

Three Years in Tibet: Secrets, C-130s, and the CIA

AIR & SPACE

Smithsonian

MINUTEMAN III

SPEED: 18,250 MPH

ALTITUDE: 60 MILES

The cold war is not over on Kwajalein, a small atoll in the South Pacific regularly bombarded by U.S. Air Force test missiles. In two years, the base on Kwajalein will fire a missile back and find out if we can knock down an enemy warhead.

INCOMING!

JAN 1998 • \$3.95 U.S./\$4.50 Canada



There are over 2 million
miles of paved road in the
United States.

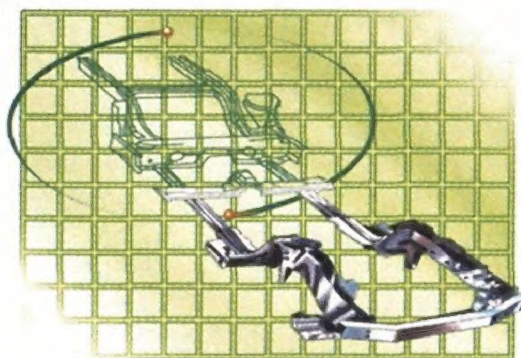


So many roads. So little time. That's the feeling you get behind the wheel of the Dodge Stratus ES—an intelligently designed sedan that was specifically engineered to make driving more of what it should be—fun.

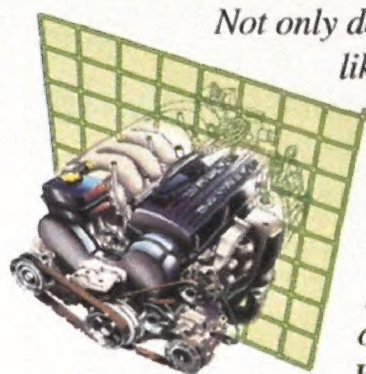
An available AutoStick® transmission combines the convenience of an automatic with the control of a stick. Just place the gear selector into Drive for automatic shifting, or drop it into the AutoStick mode and enjoy the exhilaration of clutchless manual shifting.



By incorporating steel rails and crossmembers, we developed an extremely rigid unibody that minimizes flexing and twisting to provide a solid foundation



for Stratus' modified double-wishbone suspension. The result is a smooth ride with firm, responsive handling. Your daily commute may never be the same.



Not only does Stratus look like it can perform, it backs it up with an available 2.5L, 24-valve V-6 that delivers plenty of power on demand. Just say when.

This race-modified Stratus was developed largely in-house and was the first American-built car to compete in the North American Touring Car Championship. Obviously, our designers and engineers know a thing or two about performance. We think you'll agree.

To find out more about Stratus, call 1-800-4-A-DODGE or visit our Web site at www.4adodge.com



Lucky you.



Stratus  The New Dodge

Always use seat belts. Remember a backseat is the safest place for children.

LAND
ON THIS,
FLYBOY.

Microsoft

Where do you want to go today?



Endorsed by:
FlightSafety
international



BOMBARDIER BUSINESS AIRCRAFT

©1997 Microsoft Corporation. All rights reserved. Microsoft and Where do you want to go today? are registered trademarks of Microsoft Corporation. Other products and company names mentioned herein may be the trademarks of their respective owners.

Look here ace, you've got just 90 feet of runway before you earn your wings the hard way. Face it. Your fixed-wing rules do not apply here. What you need is a helicopter.



And now you've got one in Microsoft Flight Simulator 98, an upgrade guaranteed to blow



all past flying experiences out of the sky. With it you'll soar over vastly improved landscapes that include

3000 airports (10 times more than the previous version) and more than 45 cities around the world.

Flight Simulator 98 features multiplayer, force feedback support and flight models validated by Cessna® and Learjet,



so you can achieve all new levels of flight realism. Take control of the widest range of aircraft, including this Bell 206B JetRanger III helicopter, a machine that's guar-

anteed to make you feel like a rookie all over again.



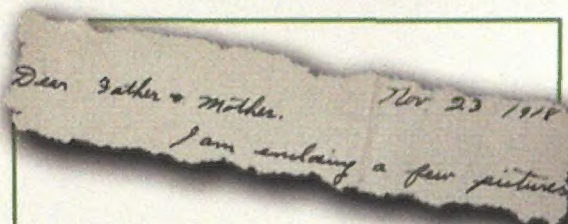
Your coordinates for take-off are www.microsoft.com/games/fsim

AIR & SPACE

Smithsonian



26



42 Letters From the Front

Lewis C. Plush described his 15 months in World War I France as "a book that leaves a lasting grip on the imagination." The same could be said of the young aviator's letters home.



62

CONTENTS

26 Catch a Falling Missile

by Tony Reichhardt

Photographs by Chad Slattery

Residents of the Pacific island of Kwajalein have grown accustomed to a casual lifestyle, tropical breezes, and incoming Minuteman III ICBMs.

38 Sky Raves by Frank Kuznik

Illustrations by Richard Thompson

At these popular nighttime parties, you won't be able to see your fellow revelers, but you'll know you have a lot in common.

52 Commentary: GPS, Inc. by Albert W. Blackburn

Changing the ownership of the Global Positioning System could turn a good navigation system into a great one.

54 Surfing the Solar System by Michael Milstein

A close look at our planetary neighbors is confirming there's water, water everywhere.

62 Secret Mission to Tibet by William M. Leary

Illustrations by Ken Dallison

Illuminated by moonlight, men and supplies quietly dropped from cargo planes flying low over Tibet. The goal: to aid the 1950s resistance against the Chinese. The sponsor: the CIA.

72 The North American Fish Spotter by Joseph Bourque

In the cutthroat competition of commercial fishing, airplanes can make a difference. They can also make enemies.

80 Monster Engines by Bruce D. Berkowitz

Those who worked on these giant reciprocating engines remember their size, their power, and their deafening roar.



54



Cover: In a time exposure by David J. Paquin, disarmed warheads streak toward the water off the atoll of Kwajalein.

Departments

- 6 Viewport
- 8 Letters
- 14 Soundings
- 20 In the Museum
- 22 Above & Beyond
- 24 Flights & Fancy

- 88 Sightings
- 90 Reviews & Previews
- 98 Credits
- 98 Calendar
- 99 On the Web Site
- 99 Forecast
- 100 Collections

AIR & SPACE/Smithsonian (ISSN 0886-2257) is published bimonthly by the Smithsonian Institution, 900 Jefferson Drive, Washington, DC 20560. ©Smithsonian Institution, 1997. All rights reserved. Reproduction in whole or in part without permission is prohibited. Editorial offices: 370 L'Enfant Promenade SW, 10th Floor, Washington, DC 20024. Advertising and circulation offices: 420 Lexington Ave.,

New York, NY 10170. SUBSCRIPTION PRICES: U.S. and possessions: \$20 a year payable in U.S. funds. Canada and all other countries: add \$6.00 (U.S. funds) per year. Eighty-five percent of dues is designated for magazine subscription. Current issue price: \$3.95 (U.S. funds). Back issue price: \$5.00 (U.S. funds). Periodical postage paid at Washington, D.C., and additional mailing offices. MAILING LISTS: We

sometimes make our subscriber list available to companies that sell goods and services by mail that we believe would interest our readers. If you do not want to receive such mailings, send your current mailing label or exact copy to: AIR & SPACE/Smithsonian, Mail Preference Service, PO Box 420113, Palm Coast, FL 32142-0113. ADDRESS CHANGES AND SUBSCRIPTION ORDERS: mail to

AIR & SPACE/Smithsonian, PO Box 420113, Palm Coast, FL 32142-0113; call 1-800-766-2149 (outside the U.S. call 1-904-445-4662); visit Web site <http://www.smithsonianmag.si.edu>; or go to the Smithsonian Online area of America Online (keyword: Smithsonian). Postmaster: Send change of address to AIR & SPACE/Smithsonian, PO Box 420111, Palm Coast, FL 32142-0111.

If you think it's hard getting to

MARS

try getting to plaque three millimeters

BELOW THE

GUMLINE.

With all due respect to the Pathfinder program, exploring the farthest reaches of *inner space* can be almost as challenging. That is, unless you have the



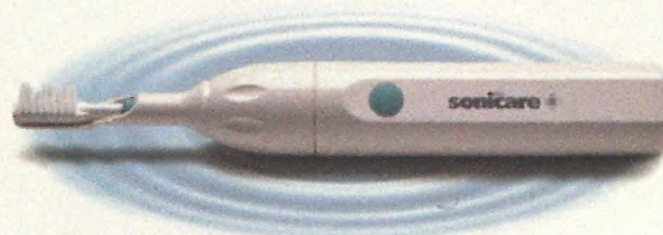
sonicare® sonic toothbrush. Not only does it remove plaque

bacteria from the surface, its 31,000 brush strokes per minute also create sonic waves which go *beyond the reach of the bristles™*¹

Gently cleaning between teeth and even below the gumline.¹ In fact, **sonicare** removes hidden plaque bacteria between teeth better than the leading power

- Reduces the risk of gum disease.¹ Proven to help shrink periodontal pockets¹ and reverse gingivitis.¹
- Cleans so effectively, it gently removes over 80% of coffee, tea and tobacco stains.¹
- We guarantee a better check-up. If you don't have one after 90 days, we'll gladly refund your money.
- Ask your dentist or hygienist. Over 98% of those who've tried us, recommend us.²

brush.¹ So like the Mars Sojourner, we too like to seek out life forms in hard-to-reach places. Only we blow them away.



sonicare®
A better kind of clean.™

Call 1.888.676.SONIC • www.sonicare.com

Secretary of the Smithsonian Institution
I. Michael Heyman

Editor
George C. Larson

Executive Editor
Linda Musser Shiner

Senior Editor
Patricia Trenner

Senior Associate Editor
Perry Turner

Associate Editors
Karen Jensen
John Sotham
Diane Tedeschi

Photography/Illustration
Caroline Sheen

Design Direction
Phil Jordan
Gretchen L. Maxwell

Cover Design
Lasko Design

Publisher
Ronald C. Walker

Administration
Carey O. Randall, Associate Publisher

Advertising
Louis C. Kolenda, DEO LLC

Circulation
Liberta Abbondante, Director
Caroline Topak, Marketing Director
Elizabeth Hopkins, Planning Director
Andrea Sole, Fulfillment Director

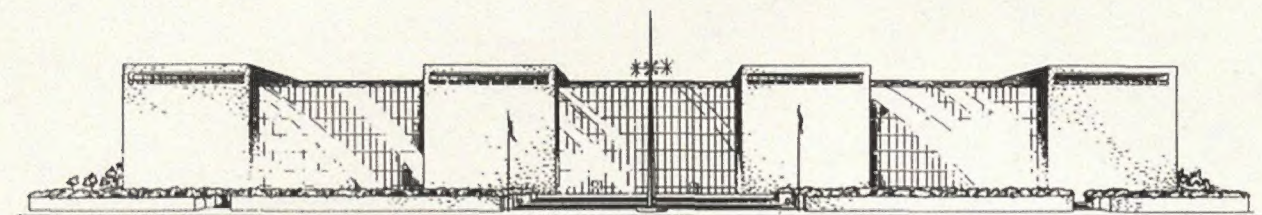
Production
Sarah D. Kingsley, Manager
Sue Nixon, Editorial Production

Business
Shelia Perry Brannum, Manager

Founder
Walter J. Boyne

Publisher Emeritus
Joseph J. Bonsignore

Telephone/Fax numbers
Editorial: (202) 287-3733;
fax: (202) 287-3163
Advertising: (415) 454-9782;
fax: (415) 454-9785



In My Book

Did you ever think about writing a book? It seems like an easy enough thing to do. You might think, as I did, that the process is simply a matter of organizing your thoughts and putting words on paper, but I'm here to tell you that you're in for a rough flight, with clear-air turbulence, blowing snow, and zero visibility. Add to that months of discovery, soul searching, and drudgery—plus learning all about the business side of publishing. If I'm making it seem daunting, that's because for me it was. Here's how it happened.

Just before I became the National Air and Space Museum's director, I was appointed the Dewitt Ramsey Fellow at the Museum. The Ramsey Chair is dedicated to naval aviation history and carries with it the expectation that the chair holder will write a book, which I guilelessly set out to do. I was told that the memoir format would be best for the kind of book I had in mind.

I wanted to write about the introduction of jet airplanes into the U.S. Navy. I had been part of the process when we naval aviators had made the transition from piston-powered airplanes concurrently with the U.S. Air Force. But flying from aircraft carriers had provided a whole new dimension to the problem, and it took about 25 years before we had it all together. During that time both services went from having too little thrust to having enough thrust to exceed Mach 2.

You may think your memory is good; I did. But I have to tell you, it's not always trustworthy. Stories grow more vivid in our minds until they are, well...not exactly the way the actual events happened, at least in some of the details. Pilots in particular are prone to tell better—make that taller—stories than others do, and these tales seem to improve with age. Does any of this sound familiar?

So I set off searching pilot and ship logbooks, old letters, newspapers, and

personal papers. I looked through eight personal cruise boxes packed with vintage stuff. I asked friends to help me confirm my facts, and their responses would occasionally take me off in a completely different direction. Our old pilot buddies may be our friends, but that doesn't mean they are immune from the memory problem too.

An interesting source of facts—and this may tell you about my tendency to be a pack rat—is the trash or treasure found in old flightsuits and other gear. Pilots' kneepad notes scribbled during a long-ago test flight or a certain cross-country to Seattle and later stuffed into a file folder or the pocket of a flightsuit can prove great memory joggers. Whenever I would come across such a gem, I mentally thanked the squadrons that used kneepad flight-procedure cards in the years before our current high levels of standardization.

In the process of research, I found also what I came to call "the first out" phenomenon: The author first to record an event or incident in print is the one who, in effect, stakes a claim on the truth. Never mind that he or she may not have been a participant or even a witness to the event.

Well, the book is finally done. *Wings and Warriors: My Life as a Naval Aviator*, covering 25 years of active flying, is published, and now it is the reviewers' turn. With its publication, I join the Museum's deputy director, Don Lopez, as a bona fide author. (His book, *Into the Teeth of the Tiger*, was first published in 1986 and has just been re-issued with additional text and pictures about combat flying in China during World War II.)

Technically, I never actually finished my term as Ramsey Fellow; I moved from the Ramsey Chair to the director's desk before the term was up. But they said they expected me to produce a book, and now they have one.

—Don Engen is director of the National Air and Space Museum.

THROUGH HIM, AMERICA REACHED THE STARS.



On April 12, 1981, America's next great leap into space exploration began. On that day, the viability of the first reusable launch vehicle, the space shuttle, was tested and assured, piloted by astronaut Robert L. Crippen.

Now G.I. Joe salutes the heroic courage of America's first shuttle pilot with this new, authentically-styled historic replica. Captured as only G.I. Joe can, this limited edition 12" tribute recreates this historic mission down to intricate detail, including authentic NASA flight suit, helmet, oxygen tanks, and ventilator.

Turning points in the history of space exploration happen but once in a lifetime. With this limited quantity figure sure to be in demand, act now to ensure this important figure is part of your historical collection.

G.I. JOE
CLASSIC
COLLECTION

The First Name In Authentic Military

Secretary of the Smithsonian Institution
I. Michael Heyman

Director, National Air and Space Museum
Vice Admiral Donald D. Engen,
U.S. Navy (ret.)

Board of Regents, Smithsonian Institution

Ex Officio

Chief Justice of the United States
William H. Rehnquist, Chancellor
Vice President of the United States
Albert Gore Jr.

*Appointed by the President
of the Senate*

Honorable Thad Cochran
Honorable Bill Frist
Honorable Daniel P. Moynihan

Appointed by the Speaker of the House

Honorable Sam Johnson
Honorable Bob Livingston
Honorable Esteban E. Torres

Appointed by Joint Resolution of Congress

Honorable Howard H. Baker Jr.
Honorable Barber B. Conable Jr.
Mr. Louis V. Gerstner Jr.
Dr. Hanna H. Gray
Ms. Anne d'Harnoncourt
Dr. Manuel L. Ibáñez
Dr. Homer A. Neal
Mr. Frank A. Shrontz
Mr. Wesley S. Williams Jr.

*Contributing Editors,
Air & Space/Smithsonian*

Michael Beschloss	Frank Kuznik
Roger Bilstein	W. David Lewis
William E. Burrows	Stephen Maran
Eric Chaisson	Laurence Marschall
Tom Crouch	Ted Maxwell
David DeVorkin	Ron Miller
Ron Dick	James Oberg
Freeman Dyson	Edwards Park
Daniel Ford	Dominick Pisano
Greg Freiherr	Robert E. Pollack
Owen Gingerich	Fred Reed
Donald Goldsmith	Tony Reichhardt
Stephen Jay Gould	George Robinson
George Greenstein	Theodore Robinson
William Gregory	Chad Slattery
R. Cargill Hall	Marcia Smith
Richard Hallion	Robert W. Smith
Jim Hansen	Jill Tarter
Gregg Herken	Steven L. Thompson
Nick Komons	Albert Van Helden
Nick Kotz	G.L. Verschuur
Saunders B. Kramer	Stephan Wilkinson

Stuck in Her Memory

The reference to the Elba Comet in "The Reconstruction" (Aug./Sept. 1997) brought back memories. In the 1950s I was a stewardess for BOAC flying on Argonauts—airliners developed from the Douglas DC-4 Skymaster. Those were bad years for the airline; it lost three Comets, a Constellation in Singapore, a Hermes in Kano—and there may have been others I've forgotten.

At some time in that period, an Argonaut stewardess on her first trip ran into some unique trouble. She was in the bathroom when the outlet from the toilet became unsealed. The resulting suction kept her firmly glued to the loo. The aircraft had to reduce altitude in order to reduce the suction so she could get up.

Soon after that, a window on a Stratocruiser blew out over the Atlantic. A quick-thinking steward slapped a tray in

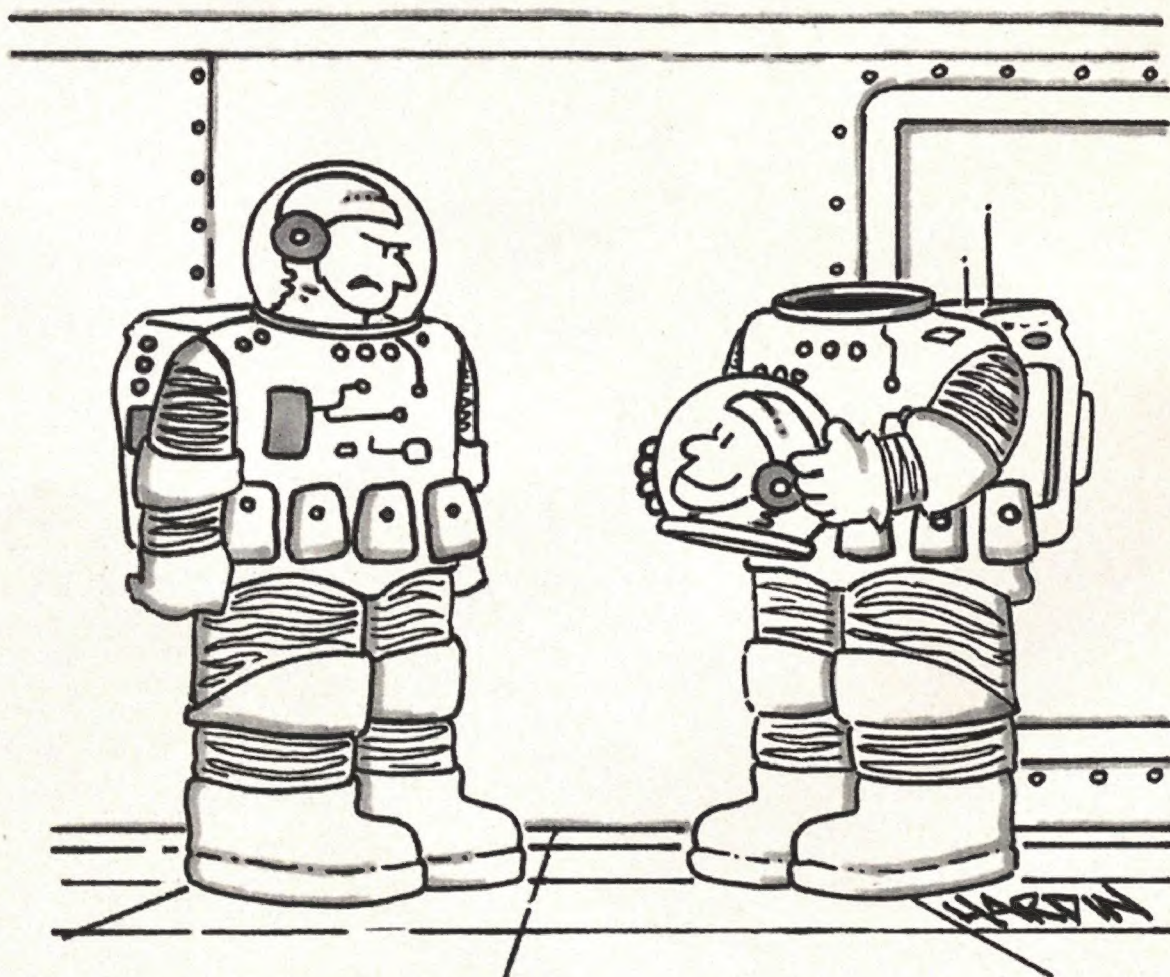
the hole, which held the pressurization until the aircraft descended. After that, crews would joke: "On Strats they use a tray to fix the pressurization; on Argonauts they use the stewardess' ass." Dated humor; not P.C. There was only one stewardess per crew in those days, so you either shared in the laughter at the funny side of aviation life or you had a miserable time. Today's crews don't look as if they have as much fun as we did—which was of course the flip side of living with fear and danger.

—Margaret G.S. Lloyd
Verplanck, New York

Out of the Picture

You blew it.

Ever since the magnificent 50th anniversary airshow at Nellis Air Force Base in April, I have been waiting to see



"Now Henderson, cut that out!"



an article about it. Just about every airplane the Air Force and its predecessors have ever flown, from World War I craft to a mockup of the F-22, was there. But when I saw that all your magazine had were pitiful photos of *people* (Sightings, Oct./Nov. 1997) and then read that the photographer had never been to an airshow and couldn't track the planes, I was astounded! How could you use this report? Even my husband and I, absolute amateurs, got some good photos of the planes flying by.

—Helen Baczynski
North Las Vegas, Nevada

As a C-5 loadmaster, I breathed a sigh of relief to see the picture of the C-5's cargo bay. I was especially relieved that you didn't include the "Gucci boys," as we've taken to calling KC-10 crews, even though they got so much coverage in "Tankers" (same issue).

I know that the crews at the Golden Air Tatoo were happy to share their airframes with the public, as well as their pride in the Air Force's 50th anniversary. Thank you.

—Nick Ochs
Travis Air Force Base, California

Keep Aviation Out of the Bedroom

I feel the cartoon on page 92 of the Oct./Nov. 1997 issue is in very poor taste. It degrades the Smithsonian Institution, as well as a fine airline name—TWA.

Leave those cartoons for the "smut" magazines.

—Joseph T. Ropar
North Huntingdon, Pennsylvania

Keep Counting

I have been involved in the support and design of many aircraft during the Air Force's 50 years. The aircraft you

included in your "USAF 50th" graphic supplement (Oct./Nov. 1997) were fine, but many of the aircraft associated with the experiences of your older readers were excluded.

You excluded the F-51D and -H, which flew in the Korean war, as well as the strange F-82, which was two Mustang fuselages on a single wing. (This was the airplane, with its eight-hour missions, that inspired the term "Dinghy Butt.") How about the T-6 trainer or its attack variant, or the T-33, which gave our pilots their first jet experience? Where was the C-123 in its various versions? And what about the Grumman amphibians the Air Force used?

—David H. Brazelton
Bradenton, Florida

Another display of Air Force aircraft with no C-133. I put in three years as a C-133 engine mechanic at Dover Air Force Base in Delaware, and I wonder why there is never a mention of this aircraft.

Granted, it wasn't the best in the world. Heck, if you painted it red, you could pass it off as the Aerial Oscar Meyer Wienermobile. I would just like to see it get some recognition sometime.

—John Mann
via e-mail

Editors' reply: Because we limited ourselves to 50 aircraft, we favored those that began flying after the Air Force's 1947 founding; we made exceptions for earlier aircraft that made significant post-1947 contributions, such as the C-47 and C-54. Introduction of the jet engine had its most immediate effect on the development of fighter aircraft, so we excluded late propeller-driven fighters—even those that made significant contributions during the Korean war—in favor of early jets. Finally, many of the aircraft not directly depicted, such as the C-133 and T-33, were referred to in text blocks for other aircraft.

In deciding to stick to 50 aircraft, we had to exclude some that made important contributions, and we do regret that.

Your Advice Stinks

Dan Kovalchik says that NASA safety engineers taught him that to get out of the way of hazardous vapors, he should "get out of the building, check the windsock, and run upwind from leaks" ("Hyperventilation," Flights & Fancy, June/July 1997). This is fine if you know where the vapor's source is and the distance to an upwind location is short. Otherwise, you could end up running through increasing concentrations of the vapor and may not make it.

The safest direction to run is at right angles to the wind. Since you won't know

which part of the plume you are in, such a course could take you all the way across it, but the wider the plume, the lower the vapor concentration.

And of course you should hold your breath as long as possible while running.

—Peter J. Davis
Paris, Virginia

Lost: One Whale. Don't Bother Returning.

I was the commanding officer of the USS *Ticonderoga* when that A-3B Skywarrior—or "Whale," as we lovingly called it—disappeared ("Ghost Story," Above & Beyond, Aug./Sept. 1997). After it happened, the air department and I breathed a sigh of relief. Great though she was, her loss gave the flight deck crew more flexibility, and we completed our cruise without further problems. (We did have to pay a ransom of 10 gallons of ice cream per rescue ship to get the A-3's air crew back the next day.)

—Capt. J.G. Daniels
U.S. Navy (ret.)
Kailua, Hawaii

The incident O.H. Billmann described occurred during my first WestPac cruise, and the plane that disappeared was from my squadron. That A-3 was a nightmare, with wiring problems that affected communications, navigation, electrical, and electronic countermeasures systems. Ironically, when this Whale went flying out of our lives, it did so with all electronics systems finally working.

One member of the squadron wrote an ode to the plane; it was based on the Flying Dutchman, since the craft may still be doing lazy circles over the Pacific.

—Bob Heise
Bloomington, Minnesota



If we had just removed the roof

By David Hill, C

One of the primary objectives when we designed the C5 Corvette® was to make sure it handles superbly. We would not be happy with



{ The coupe has the same stiff structure, rear-mounted transaxle and revised suspension as the convertible. }

anything short of an outstanding sports car, whether a coupe or convertible. It was critical that we didn't just take the coupe and chop off the top to make a convertible. The fact is, the newest

Corvette was designed as a convertible right from the outset. It was the best way, the only way in our minds, to make a car with extraordinary feel and handling.

Stiffness and Strength We didn't want this car to suffer from the ride setbacks other convertibles typically have. One particular concern was how to avoid cowl shake, a common side effect of removing a car's roof. So, we made the structure very rigid. The previous 48-piece frame rails were replaced with twin seamless hydroformed tubes. Our new hydroformed frame rail is much more durable than a welded-up one. In fact, the structure was tested to endure up to three lifetimes of Corvette usage. And not only is the C5



{ The C5 was designed without a roof from the beginning

four-and-a-half times stiffer structurally than its predecessor, it also has a lower curb weight.

The difference in rigidity is immediately noticeable; lateral shake is virtually gone, even in the absence of a structural crossover bar.



T h e N e x t C o r v

out the C5 Corvette, after all.}

It would have been a tragedy.

Chief Engineer



make a world-class sports car that's also a convertible. }

User-Friendly Convertible Once we perfected the structure, our next priority was to make every millimeter of the car work for the driver, especially in terms of comfort, spaciousness and cargo. We wanted the car to be easy on the driver, a rare



feat in convertibles. So, the controls and functions were placed where it would be natural to reach for them. Entry and exit are easier because door-sills are almost four inches lower. We've increased the hip, shoulder and leg room. There is four times more cargo space with the top down than with a C4. Partly responsible for this are the run-flat tires, which make a bulky and weight-adding spare tire unnecessary. (The instrument panel will alert drivers when a tire needs air.) These measures were taken simply because we wanted customers to avoid inconvenience wherever possible.

Power and Performance An obvious worry was whether we would lose the true spirit of a sports car by making it too civilized. We went to great lengths to keep that spirit alive. The newest Corvette has an aluminum small-block V8 that produces 345 horsepower at 5600 rpm, 350 lb.-ft. of torque at 4400 rpm and, in coupe form, achieves a 175-mph top speed.

Although it delivers more horsepower and torque than the iron version it succeeds, the C5 engine weighs 44 pounds less and is smaller in size. Basically, we packed more power into a more compact unit. We could keep the hoodline low, which would improve both aerodynamics and driver visibility.

Making No Compromises Perhaps the most vocal customer opinion was that they wanted a no-compromise sports car; they didn't want to sacrifice ride comfort for the sake of performance. We found breakthrough methods to meet those requirements. Like the composite, balsa wood-cored floor. It minimizes vibrations for the cockpit

occupants, while being both lightweight and strong enough to help deliver a more fatigue-free driving experience.

The stiff new structure and revised suspension



{ Design attributes like the nostalgic waterfall make the new C5 immediately recognizable as a Corvette. }

also demonstrate how there are no take-aways in the new convertible. By shifting the transaxle to the rear, we opened up more leg room. This also freed up room for a structural tunnel down the middle of the car, which increased its rigidity. That rigidity lets the suspension do its job properly; instead of compensating for chassis flex, it can focus on the most important things: precise handling and a smooth ride.

The Next Corvette The C5 convertible proves it is possible to marry high performance with top-down freedom. Simply put, this thing is incredible. Even more than the coupe, it will far exceed people's expectations. It even exceeded mine. See why on the showroom floor.



Call 1-800-950-2438
or visit www.chevrolet.com

©1997 GM Corp. Buckle up, America! [GM logo]

Refueling Revisited

How can you possibly write about aerial refueling ("Tankers," Oct./Nov. 1997) and not mention aerial refueling of helicopters? Hundreds of pilots rescued during the Vietnam war owe their lives to the aerial refueling of HH-3 and HH-53 rescue helicopters by C-130 tankers. Today, all large helicopters of the special operations forces are equipped for aerial refueling.

—David C. Delisio
Walkersville, Maryland

Britain's Flying Wing—Revealed at Last?

In his letter in the last issue, Richard Heier brought up the flying wings designed in Germany. I lived in England back in the 1960s, and one day, while driving to London, I saw what appeared to be a monstrous flying wing take off, spewing thick black smoke from its engines. Did Great Britain also experiment with a flying wing?

—J. Robert Wagner
Norristown, Pennsylvania

Editors' reply: Dan Hagedorn of the National Air and Space Museum archives suggests that what you saw was actually one of the Royal Air Force's "V" bombers, such as the Avro Vulcan (see "Snapshot," Above and Beyond, June/July 1989).

Blue Brothers

As amazing as it might seem, I was listening to "Barnacle Bill, the Pilot" at the exact moment I started to read "Out of the Blue" (Above & Beyond, Oct./Nov. 1997).

A few months ago, a buddy and I had been working on his car. The work wasn't going anywhere, so we decided to go to a thrift store and look for a bowling ball. We started looking through the record section and came across a goofy-looking album. Both of us plan to join the Air Force after we get out of high school, so we pooled our money and bought *The Wild Blue Yonder* for 35 cents.

I had figured that the two of us were the only people who had heard those songs in 20 years. I am glad to hear that we are not the only ones with "The Goddamned Reserves" stuck in our heads.

—Nick Noreus
Gladstone, Michigan

As I turned to "Out of the Blue," the top picture on page 21 hit me like a burst of turbulence. My eyes opened wide and

I exclaimed loudly: "I have this!"

I too grew up listening to the songs on this album. My father flew F-86s with the Air Force's 35th Fighter Bomber Squadron, "the Black Panthers," in Korea in 1953. As a child, I did not know what some of the lyrics meant but neither did I care. I liked them because they were a part of my father's life. He died in 1969, when I was 12 years old.

Through the years I have occasionally taken the album out and listened to it. I always knew where it was and never let it out of the house. After reading your article, the first thing I did when I got home was play it again—loud.

Thank you, John Starr, for helping bring back memories of my father.

—William L. Plaster
Chocowinity, North Carolina

I arrived at the Air Force Academy in 1960, and in those days we drilled, showered, and spit-shined shoes to the Oscar Brand ditties. I clearly recall buffing floors every Friday night to verses of "The New Guinea Strafers."

—Lt. Col. Frederick V. Malmstrom
Washington Court House, Ohio

Clowning Around in the Army

When the Army aviation demonstration team was formed, I volunteered to serve as one of the first square dancers and also the clown pilot ("Hover Dance," Oct./Nov. 1997). The work provided me with a welcome diversion from flight instruction.

I don't remember how I heard of the barrel-rolling stunt, but I developed it into a reliable act for the demonstrations and it was well received and much applauded. There's no business like show business.

—Major T.R. Howarth
U.S. Army (ret.)
Highland, Indiana



X-1: More Rare Pictures

I enjoyed "X-1: An Inside Look" (Aug./Sept. 1997). I have some pictures of the first X-1 (then called the XS-1) at Pinecastle Field in Florida in 1946, where it underwent glider trials before being sent to California for powered flight testing. The pictures were taken by Norman Hayes, who was the instrument leader for the National Advisory Committee for Aeronautics.

In March 1947, I came from NACA's Langley center to become the crew chief of the second XS-1 (no. 6063) at the Army Air Forces' Muroc center in California. After Bell left, I was crew chief of both the first and second XS-1 until the Air Force decided to have its own crew. I was the first NACA employee to go up on a drop of the XS-1.

Yesterday while I was at the International House of Pancakes for breakfast, I said hello to General Robert Cardenas, who had piloted the B-29 mothership during the XS-1 program at Muroc. Small world.

—Donald E. Borchers
Lancaster, California



Opposite, top: Walter C. Williams (left) with two unidentified personnel. Williams headed the NACA team that supervised XS-1 flight testing at Pinecastle. Left: Bell pilot Jack Woolams, who flew the XS-1 in the glider tests, uses his back to lift the aircraft so the nosewheel can be checked. Below: The B-29 that launched the XS-1 was adorned with a droll symbol of the project—a stork bearing a forward-looking Cupid. Opposite, bottom: Leroy Proctor (left) and Donald Borchers, our correspondent, take a break at Muroc, where the XS-1 went after the Pinecastle tests.



Corrections

Aug./Sept. 1997 "Stakeout": The picture on p. 76 shows Krushchev holding a photograph of coins found on Gary Powers, not photographs recovered from Powers' U-2.

"X-1: An Inside Look": The only X-1 to make a conventional takeoff was the first, no. 6062, not the second.

June/July 1997 "Dodging a Bullet" (In the Museum): Powers did not eject; he abandoned that idea because he feared losing his legs. Instead, he opened the U-2's canopy and was thrown out of the aircraft.

Write to us at: Letters, Air & Space/Smithsonian, 901 D St. SW, 10th Floor, Washington, DC 20024. Please type or print clearly. You must include your full address and daytime phone number. Letters will be edited for publication.

Air & Space is not responsible for the return of unsolicited photographs or other materials. We regret that we cannot answer every letter personally.

e-mail You must include your full name, mailing address, and daytime phone number. America Online: airspacedt, CompuServe: airandspace, Internet: editors@airspacemag.com.

Reaching for the Stars by Artist and Astronaut Alan Bean

A limited edition of historical importance signed by astronauts of the Mercury, Gemini, Apollo, Skylab, and Apollo-Soyuz programs. This "fine art textured canvas" is virtually like owning an original painting. Partial proceeds will benefit The Astronaut Scholarship Foundation and the expansion of the U.S. Astronaut Hall of Fame.

Only 1500 signed, countersigned, and numbered. 27" w x 34" h. Suggested retail \$2,200.

For a dealer nearest you, please call at 1-800-859-3474 in the U.S. and 1-800-263-4001 in Canada.


THE GREENWICH
WORKSHOP
The Art of Discovery®

Visit our website at
www.greenwichworkshop.com

The Price of Vigilance

They were missions for which there would be no accolades, no medals, not even official acknowledgments, but they required immeasurable courage: to penetrate Soviet airspace in unarmed, mostly heavy and lumbering aircraft, collect electronic signals and other types of intelligence, and fly home without getting shot down.

Many aircraft and crews didn't make the return trip, vanishing in a haze of official denials and cold war silence (see "Beyond the Iron Curtain," Aug./Sept. 1994). But today, with former Soviet military hardware for sale and the Moscow offices of the KGB a new tourist hot spot, the crews who flew these missions can finally be honored. Perhaps more meaningful to their families is that after decades of denials, the intelligence community can fully and publicly acknowledge that the missions even took place. According to the National Security Agency, 152 cryptologists were killed on duty during the cold war, including 64 who died while involved in aerial operations that included B-29s, EC-121s, and RC-130s.

The dedication of National Vigilance Park, held last September 2 at NSA headquarters at Fort Meade, Maryland, was centered on a C-130 Hercules rescued from a holding pen at Davis-Monthan Air Force Base in Arizona and refurbished to duplicate aircraft number 60528, a C-130A downed by MiG-15 fighters in 1958 when it entered Soviet airspace over Armenia. Among the crew were 11 "backenders," or security service personnel, collecting electronic intelligence. The Soviet Union returned the remains of six of the 17 men on board but denied shooting the aircraft down, even though President Dwight Eisenhower made public a recording of the MiG-15 pilot's radio transmissions. Not until Russian President Boris Yeltsin released a classified report decades later

could it be confirmed that no one had bailed out. The entire crew had perished in the crash.

Teresa Durkin had immediately received official notice that her brother, George P. Petrochilos, was missing, but further information was not forthcoming. She wrote to Eisenhower, but he wrote back that he could not obtain any more information on Petrochilos' fate. It was to be the first of a long series of frustrating encounters with government officials unwilling to divulge the nature of the mission and unable to get further information from the Soviets. "We wondered why they weren't doing more," Durkin says. "They wouldn't release any more information. It's only been in the last two years that anything has happened." Durkin donated Eisenhower's letter, in addition to some of Petrochilos' personal effects to Fort Meade's National Cryptologic Museum, where they are now on display.

During the ceremony, the director of

the National Security Agency, Air Force Lieutenant General Kenneth Minihan, presented Air Medals to Durkin and other family members of the crew of 60528. Minihan also offered to the families 17 folded flags that had been carried on the final flight of the refurbished aircraft as it was flown to Ft. Meade to become part of the memorial. At the close of the ceremony, three C-130s from the Maryland Air National Guard's 135th Airlift Squadron flew a missing-man formation, in which one of the aircraft pulled up sharply and left the formation.

As the ceremony ended, the crowd filtered away, the NSA Joint Service Color Guard retired the flag, and the Air Force brass band members packed up their instruments. Behind the simple plaque and the C-130, a ring of pine trees, each marking an aircraft type lost in aerial reconnaissance, remained as sentinels, their branches whispering in the breeze.

—John Sotham

RICH LIPSKI/THE WASHINGTON POST



Sighted Sub, Sunk Same

As far as reunions go, the annual gathering of the Civil Air Patrol's Coastal Patrol #2 must hold some record for sheer tenacity: Last September was at least the 52nd time the boys have gotten together since the war. Back then they were 40 not-so-eligible-for-active-duty pilots who volunteered to guard the coast around Rehoboth, Delaware, pitting their light aircraft against Nazi submarines. But they were so successful that eventually the government set up 20 similar units to patrol the East Coast until all *das Boots* had been chased out of the waters for good.

Having done this reunion business a few times before helped move the evening's events along at a swift, precise pace. During the 59-minute cocktail hour, which was marked by a decided lack of cocktails, everyone checked the message board for regrets and obits while a few pilots had their pictures taken holding the disembodied yoke of a former CAP Fairchild 24 now undergoing restoration. When the formal meeting began after dinner, none of the six original pilots in attendance felt compelled to give any repetitive, long-winded speeches. And even though Delaware governor Thomas Carper sent along a brief letter commending the group, no one read it aloud. Instead, copies were available for anyone who wanted to peruse it later at his leisure. Age bestows the right to refuse to squander one's time.

But it also tends to sharpen the sense of humor—especially about growing older. Noticing all the hearing aids among men who had spent hours behind noisy piston engines, Carl Virdin said, "If you need to get somebody's attention, just yell 'Clear!'"

They haven't forgotten their war stories, though. If you wanted to hear a

well-practiced tale, you really had to coax—about 30 or 40 reunions ago the pilots (and their wives and kids) had already heard them once or twice too often. Still, Maury Betchen would recount that early on, he and the others learned to dive their unarmed Stinsons on a lurking U-boat, which inevitably panicked the captain and forced him to scurry under cover of the deep blue. That, he said, was exactly how they kept one U-boat from torpedoing two fat, dumb, and happy U.S. oil tankers and plugging the mouth of the Delaware River with their carcasses. Only later, Betchen added, when another unarmed CAP airplane helplessly circled while a beached Nazi sub worked its way off a sandbar, did General Hap Arnold demand that CAP's fleet be outfitted with depth charges and small bombs.

Which reminded Glen Cook of the day he was flying along with another pilot who felt "spry" and wanted to loop his Fairchild 24. "As we went over the top of the loop he said, 'Oh, my God! I forgot we have a bomb on the belly,'" Cook chuckled. And then there was the time that Ed Edwards and Hugh Sharp landed their Sikorsky S-39 seaplane in high swells to pluck out a severely injured pilot. With the weather too bad to take off again and with one float taking on water, Edwards crawled out on the opposite float to balance the plane while they taxied ashore—11 hours later. "It wasn't bad," he said. "It was a warm July day and I spent a lot of the time dragging my feet in the water." For all that humble foot-dragging, Edwards became the first civilian pilot to receive the Air Medal—an honor extended in 1948 to all CAP pilots who had logged more than 200 hours patrolling the U.S. coasts. The awards were well deserved: The pilots had sighted 173 subs, bombed 57 of them, damaged 17, and sunk at least one.

After the war the pilots went back to their civilian careers, got married, raised families, then maybe retired. Now one pilot's grandkids at the reunion outnumber the original members. In the final ritual of the evening the group herded together for a photo. And even before they smiled for the camera once again they knew it would be the same time, same place, next year.

—Phil Scott

UPDATE

Slick 6's Baptism by Fire

Space Launch Complex 6 (SLC-6, or "Slick 6") at Vandenberg Air Force Base in California ("The Nine Lives of Slick Six," Feb./Mar. 1997) experienced its first successful launch last August 23 when a Lockheed Martin Launch Vehicle 1 placed NASA's Lewis Earth observation satellite in a parking orbit. But the curse that seems to plague Vandenberg resurfaced at altitude: three days later the satellite, one of the first of NASA's "faster, better, cheaper" spacecraft, started to tumble when its attitude control thrusters malfunctioned. Its batteries died and Lewis reentered the atmosphere a month later.

The Need for Speed

Space travel has never been more popular, but the vast majority of it still happens in sci-fi movies and TV shows. Manned missions to neighboring planets, much less out of the solar system, are going to stay wishful thinking until we discover a faster, more efficient means of cruising the galaxy.

Toward that end, some 100 physicists convened last August in Cleveland to hammer out a strategy for converting science fiction into real rocket science. The occasion was the first NASA Breakthrough Propulsion Physics workshop, a brain-bending evaluation of the most promising theories in interstellar transportation. Many of the ideas are already in the popular lexicon—warp drive, wormholes, tachyons, hyperspace—but have only recently emerged as serious subjects in scientific literature.

The workshop was itself a breakthrough, predicated on the very un-NASA-like idea of exploring concepts "that go beyond or appear to contradict conventional theory." Specifically, the

Chicago Daily Tribune

THE WORLD'S GREATEST NEWSPAPER



COURTESY JILL MOSLEY/CAPHF

BPP program envisions traveling faster than light, without rockets, carrying no fuel. Impossible? Absolutely, in terms of current science. But out on the visionary end of propulsion theory, there's no telling where a tweak or two of the fundamental properties of matter and space-time could lead.

"We're revisiting a lot of standard phenomena but asking different questions," explains Marc Millis, an aerospace engineer at NASA's Lewis Center in Cleveland and head of the BPP program. "Scientists are often satisfied to describe how, for example, gravity works—in the sense of if you drop an object, how fast does it fall and how does it relate to things around it? We want to know why it works that way, and if there's anything we can manipulate in the process to practical advantage."

Along with inertia, gravity is being reconsidered as a possible electromagnetic side effect of vacuum fluctuations. If that's the case, the vacuum of space may not be empty at all, but the repository of an enormous background energy known as zero-point energy, which could be tapped for propulsion uses.

Three days of wrestling with notions like that left the assemblage visibly burned out for the closing session, at which the leaders of half a dozen "breakout" teams presented the ideas each group had chosen as the most

promising for experimental research.

"It's critically important to know if the zero-point field is really there," implored the final speaker, while one of his colleagues snoozed in a chair toward the back.

"We wore people out," acknowledges Millis. "But I got what I was looking for—tangible research tasks of relatively short duration to help advocate for funding." Exactly what, if any, projects NASA funds will be decided in the budget wars. But even as an informational exercise, Millis counts the workshop a success. "We'll be doing more collaborative networking, like trading ideas back and forth on an Internet site," he says, "so even if we don't get funding right away we can keep the ideas alive until we get the research funds to test out some of them."

The workshop was by invitation only, partly to keep the numbers and logistics manageable and partly to screen out the fringe element. NASA regularly gets unsolicited papers and gizmos from amateur inventors certain they've outdone Einstein, a group Millis was anxious to avoid. Even the location of the workshop—a suburban hotel—was kept secret.

"I don't like the term 'lunatic fringe,' but we needed to filter out people who are pushing their pet theory or device," Millis says. "The day a story about the workshop ran in the Cleveland paper, I had five messages on my phone from people saying 'I need to come to this.'"

Maybe next time.

—Frank Kuznik

Losses

Nobuo Fujita, the pilot of the only enemy aircraft to bomb the U.S. mainland ("A Tree Grows in Brookings," Soundings, Oct./Nov. 1995), died last September 30 in his homeland of Japan. He was 85.

Starting in 1962, Fujita made four trips to Brookings, Oregon, to foster and maintain a friendship with the community close to where he had twice dropped phosphorus bombs in 1942 in attempts to start forest fires. His 400-year-old samurai sword now hangs in the town's library. In turn, the townspeople recently named Fujita an honorary citizen of Brookings.

The Florence Air and Missile Museum in South Carolina (Collections, Aug./Sept. 1993), resurrected from "eyesore" status in 1993, was closed last October 1 to accommodate the building of a new entrance to Florence Regional Airport. Though the airport commission offered the museum another site, the \$4.2 million required to move the collection vastly exceeded the museum's \$25,000 annual budget. Whichever of the 20-odd military aircraft in the collection that are not taken in by other museums may end up on the scrap pile.

A Signature Effort

The hotel banquet room smells like fresh vinyl. The tables are set in a wide U. For eight hours now, cotton-gloved volunteers have beaten an endless path inside the yawning block letter—serving up not a meal to the two dozen guests but print after print of a painting, "Reaching for the Stars."

The sound system plays vintage Beach Boys as each guest signs his name in the margin. "This music is really happifyin'. It takes me way back," says Scott Carpenter, nudging a blue felt-tip through what looks like signature no. 1,408. Spent pen casings litter the floor behind each autographing astronaut.

There, in the middle of it all, is the artist who created "Reaching for the Stars." Alan Bean, who began painting seriously in 1976 after returning from a Skylab mission, can't wait until tomorrow



SCOTT ANDREWS (2)

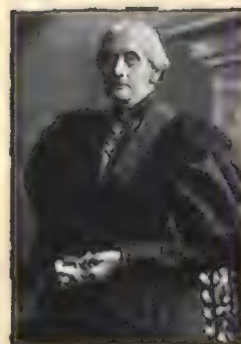
NASA's Cassini probe was launched from Florida's Cape Canaveral aboard a four-stage Titan IV in the wee hours last October 15. At 12,450 pounds one of the heaviest interplanetary spacecraft ever lofted, Cassini will get three gravity assists from Jupiter on its convoluted 2.2 billion-mile, seven-year journey to Saturn. On hand for the launch were a number of anti-nuclear activists who contended that Cassini's 72 pounds of plutonium, which powers the spacecraft's scientific instruments, could prove deadly if an accident occurred during launch or during Cassini's 1999 flyby of Earth.

"We've never seen a better credit card!"



Davy Crockett
Even he couldn't have
shot any holes in an
offer this good.

By the way,
what's a credit card?"



Susan B. Anthony
She fought to give women a voice.
And only one card lets you voice
your support for the Smithsonian.

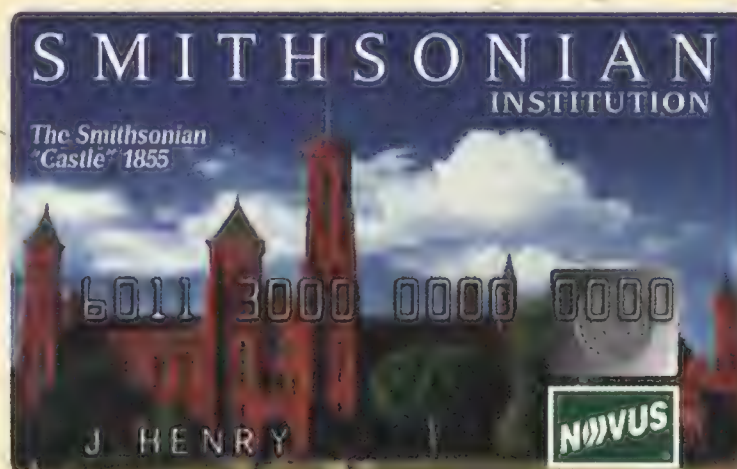


Chief Joseph
He was a brilliant leader.
And now you can lead the way
in preserving his heritage.

It's Davy Crockett's credit card. And
Susan B. Anthony's. In fact, it's the credit
card of just about any historic American you
can name. It's the Smithsonian Card.

Save For Your Future, and Support The Smithsonian.

Every time you make a purchase you'll help the Institution
preserve America's past. And you save
for your future too, because you'll earn
points toward free U.S. Savings
Bonds*. So apply today. There's never
been anything like this before in the
history of America.



To apply, call toll-free
1★888★33CASTLE

USE WHERE
YOU SEE



when the same picture—in a mural of near planetary proportions—welcomes him and 23 old friends as the newest members of the U.S. Astronaut Hall of Fame in Titusville, Florida. “Every time I paint, I think about the guys,” says the Apollo 12 lunar module pilot and Skylab 3 commander (see “To Make the Moon More Beautiful,” Feb./Mar. 1987).

From the first American to orbit Earth to the last man to walk on the moon, they came. It was one of the largest gatherings of astronauts in history, with 30 men from the Mercury, Gemini, Apollo, Skylab, and Apollo-Soyuz programs in attendance.

The occasion last October was the dedication of the Hall of Fame’s new \$4 million Apollo wing and the induction of 24 Apollo astronauts who hadn’t already been enshrined as Mercury or Gemini fliers. Proceeds from the sale of signed Hall of Fame prints were estimated at \$1 million, a portion of which will benefit the Astronaut Scholarship Foundation and the Hall of Fame expansion.

Bean—who made sure he was the first person to eat spaghetti on the moon but still kicks himself for forgetting to take along a canvas, paints, and brushes—was commissioned by the Greenwich Workshop of Shelton, Connecticut, to commemorate the induction in his impressionist style. The painting features a lone, untethered spacewalker leaping off Earth to grab a brilliant star in an outstretched hand. The work was textured with acrylic modeling paste that was mixed with a sprinkle of flame-retardant fabric fiber and a trace of moondust, which Bean obtains by grinding up his keepsake mission patches. He spreads the texturing material on aircraft-grade birch plywood. As the paste begins to dry, he sculpts it with the sole of a moon boot, the hammer used to pound the staff of the American flag into the lunar surface, and the sharp-edged bit of the hollow core tubes used to core out soil samples. Once the substrate impressions are perfect, he paints.

The mural in the Hall of Fame rotunda is a 22- by 24-foot representation of Bean’s smaller original. As the mural went up in September, Bean, ever the perfectionist, rode a hydraulic lift with the painters and personally touched up shapes, lines, and colors. He fattened the arms, shortened the fingers, and squared the buckles on the genderless astronaut, who soars 13 feet above eye level. One part the moonwalker didn’t touch: “They did a better Earth than I did,” he said.

“What the old men are doing here today [is] dreaming dreams,” Skylab 2

To commemorate the 50th anniversary of supersonic flight, Brigadier General Chuck Yeager and Bob Hoover took to the skies over California’s Edwards Air Force Base last October 14 and did it all over again, minus the suspense. This time Yeager flew an F-15D (middle) rather than a Bell X-1, with Hoover flying chase in an F-16D (below) instead of an FP-80. Yeager, 74, then announced that this was his last joyride in a military aircraft, adding that he wanted to “go out on top rather than wait for some doctor to ground me,” a fate Hoover wrestled with for two years before winning his medical certificate back in 1995.

CHAD SLATTERY



Meanwhile, in the Black Rock Desert in Nevada, Richard Noble’s Thrust SSC ultimate funny car twice broke Mach 1 on October 13 but missed setting an official record because the two runs were not made within 60 minutes. On October 15, driver Andy Green, a Royal Air Force captain, made it official, taking Thrust to 759.3 mph—Mach 1.015—and 763 mph some 55 minutes later. The 10.2-ton Thrust is powered by two Rolls-Royce Spey 205 engines, essentially the same ones used on a British version of the McDonnell F-4 Phantom II.

AP PHOTO/NASA



AP PHOTO/BEN MARGOT



crew member Joseph Kerwin told guests at the induction, the emotional content of which moved a few veteran astronauts nearly to tears. “We are thinking back with a certain smug contentment on the adventures we had. Meanwhile, you young people out there had better be seeing visions of new missions that will make ours look small by comparison, and then carrying them out.”

But Bean says the message in “Reaching for the Stars” is not just for future astronauts. “I wanted it to mean something to a kid, or to a father who works in an auto plant,” he says. “He’s got his own dreams and he can reach for them too.”

The Hall of Fame induction was part of a gala weekend that also celebrated the accomplishments of the first person to hit a golf ball on the moon—Apollo 14 commander Alan Shepard. After 13 years as chairman of the Astronaut Scholarship Foundation, Shepard handed the gavel of the hall of fame’s sponsoring organization to Apollo 13 commander James Lovell.

Among those invited to Shepard’s

satirical sendoff was Walter Cronkite. The world’s most trusted newsman at long last revealed his doubts about the golf ball, which, according to legend, is orbiting the moon. “I suspected that maybe he’d sliced off into a lunar rough,” said Cronkite, pulling the proof from his pants pocket and launching into a tale about a stroll through a Cape Canaveral junkyard full of moon mission artifacts.

“Believe it or not, and this is the honest truth, I kicked a little piece of metal and guess what I found? A golf ball. This had to be in some of the debris that came back from [Apollo] 14.”

The roast was a surprise to Shepard, as was the announcement that his command module finally would land inside the U.S. Astronaut Hall of Fame. Shepard had followed the capsule from city to city as part of the Smithsonian’s 150th anniversary touring exhibition, and he’d lobbied hard for it to join Wally Schirra’s Sigma 7 Mercury capsule, on loan from the National Air and Space Museum.

—Beth Dickey

Rock On

No one knows who gave the order, but around 1974 groundskeepers at NASA's Johnson Space Center in Houston demolished a moonscape and sowed grass. Now engineers are considering rebuilding it—with a swatch of Mars thrown in.

The Lunar Topographic Surface Area—better known as “the rockpile”—was a football field-size outdoor plot used for testing Apollo spacesuits and equipment. More than 2,000 tons of furnace slag textured the landscape where Neil Armstrong rehearsed his first small step under the hot Texas sky. “It should have been made a national historical site, like some of the launch pads and test chambers,” says Joe Kosmo, a suit technician last detailed to the rockpile in 1972, as Apollo drew to a close.

Today Kosmo builds advanced suits at Johnson. He says the new rockpile—the Lunar/Mars Surface Simulator—will have a “split personality.” Half will be undulating lunar terrain, while the other half will simulate the Earth-like Martian terrain, which has been carved by wind and ancient water. Life on Mars remains a question, but astronauts will probably encounter advanced organisms on the new rockpile. “In hot, humid Texas,” Kosmo explains, “weed control is a concern.”

Robert Trevino of NASA's Extravehicular Activity Project Office says the site will allow day-to-day engineering and testing of equipment on a realistic surface. For example, subjects wearing the latest suits might assemble a prototype spacecraft fuel factory, seen as a key to affordable exploration.

Apollo 16 moonwalker John Young rehearsed on the rockpile. Now associate director at Johnson, he supports building the new rockpile for explorers who will follow in his footsteps. Young explains: “You don't want to do something on the moon or Mars that you haven't done on Earth first.” He adds that the new rockpile will have computerized suspension rigs to allow astronauts to move as they would on Mars, which has only three-eighths the gravity of Earth. As important as the technical justifications, says Kosmo, is the fact that the new rockpile will help his generation “pass down old gray-beard knowledge” to young engineers who've known only weightless shuttle spacewalks.

—David S. F. Portree



NASA/JOHNSON

OWN IT EVEN IF YOU DON'T FLY FIGHTER JETS



BLACK STEEL FIGHTER COMMAND CHRONOGRAPH DESIGNED FOR MILITARY PILOTS

Precision SWISS ETA 251.265 Movement
6 Hands • 4 Push-buttons • 4 Dials • 1/100th Sec Timing
Dual Time Zones • Speed Tachymetre • Digital Alarm
• Hardened Mineral Crystal Lens • Twin Digital Readouts
• Solid Stainless Steel Case & Band • Tritium Hands & Indexes • W/R to 330 ft • Revolving 360° Heading Marker Bezel • 12 Hour Elapsed Time • 12/24 Hr Time display
• Calendar Month & Date Windows • Serial No.
30 Day Money Back Guarantee • 2 Year Warranty

\$800 Value NOW ONLY \$150
a month for 3 months

on credit card orders for total of \$450 + \$6 S&H

1-800-544-4365 ask for operator 463

Or send check or Money Order FOR \$456 to:
CHASE-DURER

270 No. Canon Dr, Dept 1402-463 • Beverly Hills, CA 90210
Ph 310-550-7280 / Fax 310-550-0830

On display at: LOS ANGELES, CA - Feldmar Watch & Clock, 213-272-1196
• SAN LUIS OBISPO, CA - B-Anthony Jewelers, 805-544-8988
• SAN MATEO, CA - Carlyle Jewelers, 415-344-2145 • San Antonio, TX
Mandarin Gems, 210-344-5678 • And Selected Fine Jewelry Stores

Of Diapers and Dust Bunnies

JEFF TINSLEY

As a kid, I hated to vacuum. It was only with the greatest amount of coercion that my mother was able to get me to fire up the family Hoover and run it over our gold shag carpeting. Stands to reason, then, that the job of vacuuming the wings of the *Vin Fiz*, a Wright EX biplane, would fall to me.

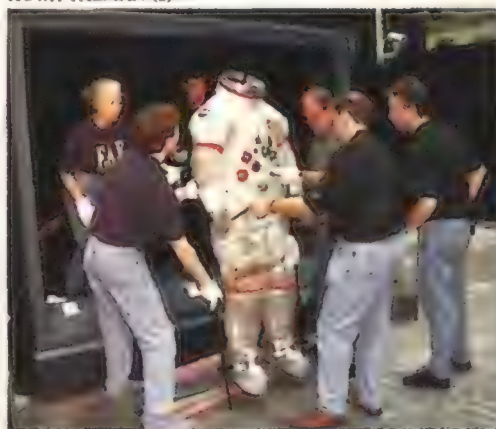
I work in the National Air and Space Museum's collections management division, and last spring I went on tour with "America's Smithsonian," the largest traveling exhibition the Smithsonian Institution has ever assembled. The ongoing exhibit features seven tractor-trailer loads of artifacts, and in addition to the *Vin Fiz*, it is hauling around the country such icons as Kermit the Frog, Abraham Lincoln's top hat, Amelia Earhart's flightsuit, Alan Shepard's Mercury capsule, and the ruby slippers Judy Garland wore in *The Wizard of Oz*.

When I was working the tour, one of my duties was to make sure that the *Vin Fiz*'s two cotton wings were free of dust. Hunched over, with the vacuum cleaner hose draped across my back so as not to catch it on the fragile 87-year-old biplane, I cleaned one small area at a time, gently loosening the dust with a soft brush, then sucking it up with the vacuum nozzle. It is an exacting and tedious process requiring up to eight hours, and it had to be done each time the *Vin Fiz* was transported to another city on the tour, but how many people can say they've cleaned the wings of the first aircraft to fly across the United States?

On September 17, 1911, Calbraith Perry Rodgers took off from Sheepshead Bay, Long Island, with the goal of landing the *Vin Fiz* on the West Coast in 30 days or less. If he succeeded, he would earn a \$50,000 prize put up by newspaper publisher William Randolph Hearst. Rodgers got the Armour Company, which had unveiled a grape-flavored soft drink named Vin Fiz, to sponsor him, but by the time he landed in Pasadena, California, 49 days had passed, so he was ineligible for the prize. On the bright side, Rodgers was still alive. While taking off from

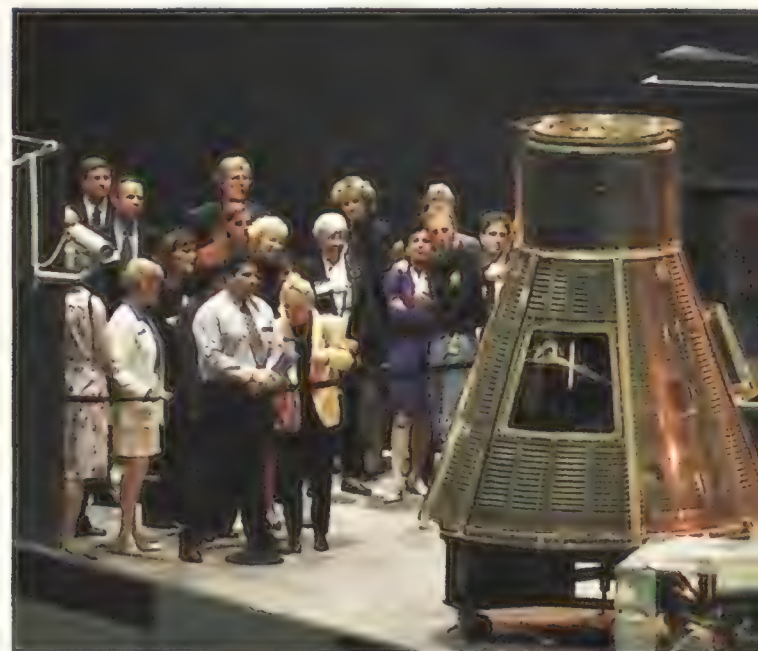


HUGH TALMAN (2)



Middleton, New York, on the second day of the trip, he flew into a tree. And though he would have 14 more accidents, Rodgers refused to be thwarted in his effort to reach the California coast. The same could not be said of the delicate *Vin Fiz*: Of the original airplane that had taken off from Sheepshead Bay, only the vertical rudder and the engine drip pan remained (the rest of the aircraft had had to be replaced, piece by piece, en route).

For the opening of "America's



Clockwise from top: The Vin Fiz biplane, Alan Shepard's Mercury capsule, and an Apollo spacesuit are among the more than 300 artifacts that hit the road with "America's Smithsonian."

Smithsonian" in Los Angeles on February 9, 1996, the *Vin Fiz* crossed the country again, rolling along interstates in a climate-controlled trailer. Total travel time: four days. When the historic airplane arrived in Los Angeles, it emerged without so much as a scratch. Visitors to the exhibit always marvel at the fact that anyone would attempt a transcontinental trip in the *Vin Fiz*. (From my own unofficial survey, even the children who would have eagerly swapped places with astronaut Alan Shepard would have left Cal Rodgers to his own devices.)

On an average day, some 9,000 visitors filed through "America's Smithsonian," and long before the doors opened, Smithsonian staffers had to put in a little elbow grease. When I was working the tour, my day—and that of two of my co-workers from the conservation department—began at 7:30 a.m. Our first task was to round up cleaning supplies—vacuums, Dust Bunnies (a remarkable brand of cloth that removes dust from a surface without the aid of cleaning solutions, which could damage the paint), and cloth diapers, prized by conservators for their softness. (We often got second looks when we arrived at laundromats with a trash bag full of dusty diapers. I hope never again to have to wash and fold a hundred diapers at a time!)

Wearing cotton gloves to prevent skin oil from damaging the artifacts, we gently wiped down Plexiglas-covered paintings, dusted automobiles and sculptures, and vacuumed any platforms on which artifacts are displayed. But even with our well-coordinated team, we were often just finishing our work as the first visitors arrived.

Throughout the day, we peered into exhibit cases to check hygrometers, instruments that measure temperature and relative humidity, to ensure that the air surrounding the artifacts remained near 70 degrees at a humidity of 50 percent. These walkthroughs also gave us the chance to talk with security people about problems they might have noticed, find out which artifacts were attracting the most attention, and answer questions from visitors. Despite the fact that we are not curators, we were often the ones called when people wanted to know more about the artifacts. Typical questions ranged from whether we drive the 1948 Tucker automobile (we do not) to why we didn't have a particular painting by a certain artist on display. Sometimes we were left completely stumped, as we were when asked where the intake and exhaust are on the *Vin Fiz*' 35-horsepower engine.

Perhaps because it is my favorite artifact, I couldn't help noticing that the *Vin Fiz* seemed to draw a lot of oohs and aahs from visitors. Certainly, it requires

much attention from the staff. Unlike other artifacts, many of which are prepared for exhibit by an art handling company, rotating teams of specialists are flown out from the Museum's restoration shop to assemble and disassemble the *Vin Fiz* at each city on the tour, and working with them was my biggest responsibility. Erecting the *Vin Fiz* takes about a day and a half. Each of its parts is labeled and assigned a space in one of many well-padded crates, so putting the airplane together is somewhat like building a giant model kit. We also have a book of step-by-step photographs should a question ever arise about how things go together.

There really is an art to handling something as old and rare as the *Vin Fiz*—something I wasn't fully able to appreciate during the tour, which didn't allow much time for reflection. There was always something to do: hotel arrangements to be made, disaster plans to be drawn up, and diapers to be washed. But I wouldn't take back a single moment that I spent on "America's Smithsonian." It's a wonderful show. And like Cal Rodgers flying the *Vin Fiz* across the country in 1911, it must go on.

—Scott Wirz

For a schedule of "America's Smithsonian," call (800) 913-TOUR.

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY (202) 357-1729.

December 27 Monthly Star Lecture. "Together in Space." Rob Landis of NASA's Goddard Space Flight Center will present a historical overview of the Soviet space program. He will also discuss the future of collaborations in space by the United States and Russia. Einstein Planetarium, 6 p.m.

Curator's Choice

Once a week a Museum curator will give a 15-minute talk about a particular artifact or item of interest. Dec. 3, Vanguard TV-3; Dec. 10, Fokker D.VII; Dec. 17, Douglas A-4C Skyhawk. Meet at the Gold Seal in the Milestones of Flight gallery at noon.

Paul E. Garber Preservation, Restoration and Storage Facility Get a behind-the-scenes look at the Museum's restoration workshop in Suitland, Maryland, where craftsmen restore everything from aircraft to satellites. Free tours Monday through Friday at 10 a.m. and Saturday and Sunday at 10 a.m. and 1 p.m. For reservations, call (202) 357-1400; TTY (202) 357-1505.



As a small crowd gathered in the Air Transportation gallery for early-morning coffee on August 7, two new artifacts became part of the National Air and Space Museum's collection. AlliedSignal Aerospace donated an early example of its TFE731 turbofan engine along with one of its series 85 turbine-powered auxiliary power units; both represent milestones in their respective niches. The TFE731 powers more business jet aircraft than any other engine, while the auxiliary power unit was the first of its type ever used in airline service, freeing the Boeing 727 from dependence on power carts. For the first time, jet airliners could come into any airport and rely on their own source of electrical power and compressed air to start engines. In accepting the new additions from Tom Johnson (left) and Dominique Hedon (right), Museum director Don Engen (center) noted that the TFE731 had powered N1, the Federal Aviation Administration's Lockheed JetStar, when he had flown it to China in May 1985. He was the first FAA administrator to visit China.

Nap of the Earth

Today, shortly after the Berlin Wall and Cuban Missile crises, we're flying big, very fast Air Force fighter-bombers on another low-level nuclear attack practice sortie. In Vietnam, they will be camouflaged and called "Thuds," but now our brand-new F-105D Thunderchiefs are still mirror-bright and tail-banded with the three red stripes of the 22nd Tactical Fighter Squadron. We've sprung from Bitburg, one of many North Atlantic Treaty Organization bases across western Europe, in opposition to similar Soviet installations among the Warsaw Pact nations.

From the low hills of West Germany, we turn away from tense border regions to train over France. Quickly we dart through Luxembourg, and then the big slag pile at Longwy appears on the radar screen. I settle over the scope to the rhythm of another low-level mission.

We are speed-readers of map, radar, and blurry scenes off the wingtip. At very

low altitude, Ed Larson and I are scampering along at 480 mph above the sodden landscape. Our glowing radar sweeps reveal character and identity on the scroll that unrolls toward us. The texture of field and forest, tracery of riverbank or railway track, mystery of escarpment or factory town are now familiar symbols.

We shred low-hanging tendrils of mist in passing, as if brushing past beaded curtains. I've got my head down in the cockpit, matching the map with the screen, picking circled points on the target map out of clutter on the radar. Patient and watchful, Ed keeps a steady lookout for the many kinds of trouble one can find down this low. The crummy weather is to our advantage; most other military contenders for this airspace will stay home. We are the back-alley thugs in this neighborhood, accustomed to slithering among the crevices and shadows of valleys and ridges.

As a ground-mapping radar, this set is barely adequate, but we have become artisans by its cold yellow glow. As I snap into a turn over a railyard, I glance back to see Ed cross behind me. He tracks the map too but leaves the radar to me. His job is to keep me from flying into the ground, or other traffic, or unplotted antennas. In training, a safety lookout is a concession to statistics, but in these last two years we have become matter-of-fact about screaming around in the rain and fog just above the wet earth.

We think about the real thing a lot. We don't sweat flak much because we are so low and fast, but the new surface-to-air missiles are a real worry. Intelligence says they are absolutely deadly. They accelerate to hypersonic speed in seconds. It remains in the future, for those who must stare down their throats in Vietnam, to prove that the SAM is not unbeatable. For now, we hope for speed and surprise—and rotten weather.



PHIL JORDAN

This tour has been my Ph.D. work in instrument flying. We are based in a small area that in winter has some of the worst flying weather on the globe. In the States, only Pittsburgh comes close. This North Sea air is wet, the freezing level low. Nasty stuff, and I love it this way. Many days we take off and never see the sun, just glimpses of the earth through slanting rain or snow.

In such weather, recovery is almost always via the instrument landing system, with a ground-controlled radar approach droning in your ears as backup. We touch down at 190 mph on a 7,800-foot runway, which is okay until you factor in an icy runway, snow, and low ceilings.

On very bad days, we need some real machinations to fly. We have dual takeoff alternates and assigned times to be over the field for our recovery. It is a sin to miss that time when there is only a two-minute separation between you and the next guy, but it happens more often than we wish. There is always the one who shows up hollering low fuel, as if everybody else didn't have the same problem, so someone more daring, or a better fuel-saver, moves over a slot.

Weather diversions are hateful things too, but sometimes unavoidable. I'll always remember a night that I couldn't see a thing at my minimum altitude and took a go-around to my alternate, way over at Laon, France. My fuel was right where it was supposed to be, but in the reality of that diversion, it seemed woefully inadequate. It was ages before Calva Radar finally answered me, in that barely interested DeGaullean attitude of the era. I was so glad to hear the G.I. voice on the final-approach control frequency. Our close work in the next few minutes was a test for us both. By the time I got on the ground, snow flurries were coming so thick that I had to wait at the end of the runway for a "Follow Me" truck to show me where to park. Twenty minutes later, he found me. I shut down with 400 pounds of fuel for a five-day stand in a dirty flying suit.

Ed and I have passed Verdun and Sedan. Ahead lie Reims, Châlons-sur-Marne, Vitry-le-François, Troyes, Montargis, and more, all steaming in the mist. It is April, but outside my canopy it is more like gray December. In a brief glimpse of the Meuse near Verdun, the zigzag of refilled trenches had alerted me, as always. There it was, off to the right: the towering monument to the World War I dead, with the ossuary below. I felt again the immense sobriety of my haunting visit there—a generation's worth of bones seen through a dusty glass wall—the ruined land for miles around.

We are soon over the lovely, meandering Loire river. Fleeting

impressions, seen in a heartbeat: tiny red airplane a quarter-mile out at twelve-thirty, hanging in memory like a spider on a thread; glittering wall of windows shining on the chateau of some long-dead duke; great roseate wheel of glass, pulsing from the face of Reims cathedral; man on a tractor. And deep in the lower Saône valley, weak sunrays glint on dripping poplars lining a highway.

We flit over the prime identification point for the final run into the target. I push the thrust lever to full quadrant stop, surging to nearly 700 mph. It's amazing, to approach the speed of sound dragging wing pylons and drop tanks, and still not require afterburner power. Everything accelerates: my breathing, the radar on sector scan, now sweeping at double rate, the target, a railroad bridge across a broad basin, now leaping down the scope at me. I glance over at Ed to see an unforgettable sight. At near sonic speed, our shock wave in the saturated atmosphere creates a ball of mist around the aircraft, completely obscuring our machines. Even this close, I can see only the long pitot boom probing beyond the apparition beside me.

What an awesome spectacle this must present from the ground, together with the thunder of our passing. To any real victim, frozen in his tracks, what a vision of doom this hurtling malevolence must present. I can imagine that the whistle of Hitler's Stukas could have been worse only for the protracted suspense. This ghostly mission would bring little suspense. Just one searing blow and then—nothing. The thought is a ghostly counterpoint to the snapshots of humanity I have seen going about their day, their works, their lives.

We flash over the bridge. Blink. Beautiful red caterpillar of a train. I begin a pullup for one mischievous blue wink out of the clouds above. In exchange for the pile of knots we accumulated moments before, the vertical velocity tape on the panel reads huge numbers. The ultimate accountant over at the fuel window calls time. Now the failing fire in the west flickers softly against the Alps. After a few seconds in the heavenly gallery, the image is curtained—a soft canopy of ice cotton has been lowering over us as we bound off the valley floor. In soupy thickness, Ed's canopy sits just outboard of my wingtip until we breach like shining marlin. At the absurd climb angle, we lunge into brilliant azure. Rolling lazily off to the horizon, I am fascinated by the rapidly receding white rumple of clouds below. Behind us trail widening streams of iced condensation, lingering markers for other pilgrims, such as I think myself today, stranger in a strange world.

—L. Alan Duaine



SPACE ART
Paintings Prints Posters Cards & More
by the world's top space artists

Kim Poor, Robert McCall, Pat Rawlings, Don Davis,
Bob Eggleton, Michael Carrol, David A. Hardy,
John Foster, Chris Butler, Attila Hejja, & more!

ASTRONAUT AUTOGRAPHED ART



Heavenly Reflections

We are the largest dealer
for limited editions by
artist & Apollo 12 astronaut
ALAN BEAN

Many prints co-signed
by other astronauts
depicted in his works

— prompt shipping —
— archival framing —
authenticity and
satisfaction guaranteed

Catalog \$3 (\$5 int'l)



**Naval Aviation
in Space**

Commemorative
ltd. edition. NINE
autographs, including

**Armstrong,
Lovell, Conrad,
Shepard, Cernan,
Glenn, Schirra**

NEAR SELL-OUT

NOVAGRAPHICS
SPACE ART GALLERY

PO Box 37197-J
Tucson, AZ 85740
(800) 727-NOVA

www.novaspace.com



The fabulous life-like images of America's
Premier Aviation Artist, Stan Stokes, are
yours to enjoy. Please write or call us toll
free for our 18 page FREE COLOR CATALOG.

THE STOKES COLLECTION

Box 1420 Pebble Beach, CA 93953

1-800-359-4644

YOU HEARD IT THROUGH THE GRAPEVINE

Urban legends are modern-day fables that sometimes grow from a grain of truth, sometimes from a joke that takes on a life of its own, sometimes from sheer fantasy. They may be recounted in great and specific detail that appears to offer a certain amount of validation ("the Arizona Highway Patrol reports that..."), and often the subject of the tale was "a friend of a friend," "somebody my father knew," or the like.

Urban legends have one other thing in common: They're impossible to confirm. Yet in the era of the unfiltered Internet, where they circulate at the speed of light, they eventually end up being "proven" by publication.

The world of aviation has contributed its share of urban legends. The best known are the hot-rodder who strapped an aircraft jet-assisted-takeoff bottle to his Camaro and pulverized himself against a desert cliff at 350 mph and the French scuba diver scooped out of a lake and dropped into the middle of a forest fire by a Canadian water bomber refilling its tanks.

There's more where those came from.

It is regularly reported that Royal Air Force C-130 crews that resupplied stations in the Falklands Islands gained their only amusement after the long flight by approaching at low altitude and overflying a certain beach thick with penguins. The penguins watched the oncoming 130s in fascination, but with no necks to crane, slowly toppled onto their backs by the thousands as the airplanes flew directly over them.

Even penguins aren't that dumb, yet at least one ex-RAF pilot swore to me that it was true—he'd seen it himself. Well, actually it was what his loadmaster had told him appeared to have happened from what he could see through the lowered aft ramp. Yet another Falklands C-130 pilot said he'd tried the overflight himself but all the penguins had done was run around, bump into each other, fall over, and generally act hysterical—what you would expect such

birds to do if a four-engine turboprop flew low over their heads. Such are the grains of truth from which urban legends grow.

Countless American airline pilots will swear that "a friend" heard a classic exchange at Los Angeles International in 1978 when a United DC-8 waiting in a long line of traffic announced that it could safely make its takeoff by turning onto the runway at an adjacent taxiway rather than waiting to follow the four aircraft ahead of it. Permission granted, the DC-8 turned onto the runway and, as it began its takeoff roll, the United captain keyed his microphone and said to the 707 that it had been following, "How 'bout them apples, TWA?"

As the DC-8 thundered off, the TWA captain waited a moment, keyed his mike, and punched an engine-fire-warning button. The klaxon hooted for everybody to hear and the entire airport

watched United go through tire-popping braking, maximum reverse thrust, and clouds of dust. The DC-8 turned off the runway at the very end, and the only words heard on a suddenly silent frequency were "How 'bout *them* apples, United?"

Policemen frequently figure in urban legends. Two cops running a speed trap near a low-altitude RAF training area in Scotland last year were stunned to see the radar gun mounted on their cruiser's dashboard indicating oncoming traffic doing 450 mph. Seconds later, the source became obvious when a Harrier buzzed the car. The RAF later informed the police that the Harrier's radar-guided missiles had automatically locked onto the gun and had come within an ace of blowing the patrol car to oblivion.

Can we blame the Internet for this proliferation of half-truth, junk science, and naiveté? "I'm skeptical about whether the Internet has had a great impact on urban legends," says Bill Ellis, a folklorist and associate professor of English and American Studies at Pennsylvania State University. Ellis is also president of the International Society for

Contemporary Legend Research. "They've been known to spread with astonishing speed by word of mouth. If one person tells two people and each of those people tells two more, in 24 hours the entire country would have heard the story."

Ellis is the former editor of the ISCLR's journal, *FOAF Tale News*—short for "Friend of a Friend"—and he warns that one characteristic of the bona fide urban legend is that "it always comes with some indication that somebody has verified it, but the person who is actually communicating it cannot vouch for it." So for all of you preparing to write letters swearing that one of these stories is not a legend but true, no fair saying that it happened to "a friend of a friend."

—Stephan Wilkinson



YOUR BEST VALUE IN A 1998 DESK CALENDAR!

NOW WITH
QUANTITY
DISCOUNTS!

The Official 1998 Air & Space/Smithsonian Desk Calendar

A genuine "exclusive" bargain produced in limited quantities, the 1998 edition of the official AIR & SPACE/SMITHSONIAN Desk Calendar will soon be ready for delivery.

Printed entirely on heavy, burnished stock and richly hardbound, this distinctive desk accessory is more than a combination calendar and daily planner.

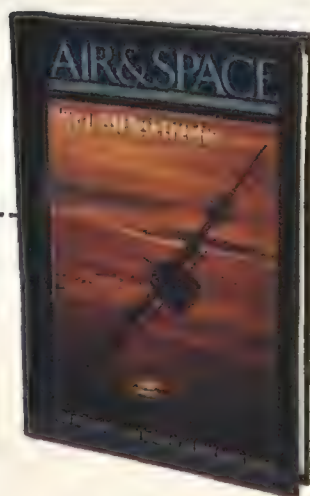
Featured throughout are over 50 rare photographs drawn largely from the National Air and Space Museum's famed archives and including many never published before. There's also detailed photo caption information and noted aviation anniversaries. Together, they capture the spirit of flight from its wood-and-wire beginnings to today's most advanced aircraft and space vehicles.

Available shortly, this special-edition 1998 desk calendar may be ordered for a modest \$13.95 including shipping and handling.

Quantities at this price are definitely limited.

So order now to guarantee delivery in time for the holiday season.

Please complete the form below and send in with your payment:



**STRIKINGLY
ILLUSTRATED!**
Photos from the
Smithsonian's National
Air and Space Museum
Archives!

MAIL ORDER TO: Air & Space/Smithsonian, 901 D Street, SW, 10th Floor, Item #A98D, Washington, DC 20024.
Phone 1-800-824-5974 toll-free to leave a recorded message with credit card and mailing information,
or fax to: 202-287-3163.

- ☐ one desk calendar @ \$13.95 (all prices incl. S&H) ☐ two desk calendars @ \$25.95 (save \$2)
☐ three desk calendars @ \$37.95 (save \$4) ☐ four desk calendars @ \$47.95 (save \$8)
☐ five desk calendars or more @ \$11.00 per calendar (save \$15+)

☐ This calendar order is for use as a 1997 holiday gift.

☐ Check or money order enclosed

Make check payable to: Air & Space/Smithsonian

☐ Discover

☐ Mastercard

☐ American Express

☐ VISA

Credit Card # _____ Exp. Date _____

Signature _____

MAILING ADDRESS (please print):

Name _____

Address _____

City _____ State _____ Zip _____

Above quantity discounts available for delivery to one location. U.S. shipping of the 1998 Desk Calendar will begin November, 1997 to accommodate 1997 holiday gift orders. Please allow up to 4 weeks for delivery. For international surface delivery beginning September 1997 add \$2 for each calendar ordered.

Catch a Falling Missile

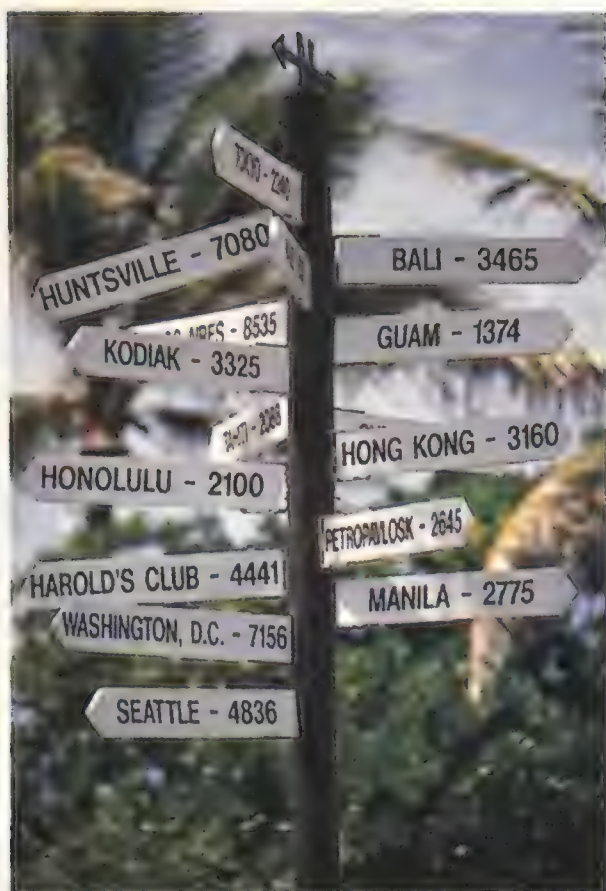
The U.S. Air Force practices firing its ICBMs at a target in the South Pacific. This is what it's like to live in the bull's eye.

by Tony Reichhardt

Photographs by Chad Slattery

The view from Ground Zero: This time exposure shows multiple reentry vehicles entering the ocean off Kwajalein during an ICBM test.





On Kwajalein, missile attacks are social occasions. Families might be sitting home after dinner, watching one of the Pacific island's two Armed Forces TV channels, when a message scrolls across the screen advising them that "The Mission"—a Minuteman III or Peacekeeper missile—has just launched from Vandenberg Air Force Base in California and is headed their way. Since they have about half an hour before it hits, they stroll out into the balmy Pacific night toward the island's north point, where neighbors are already arriving by bicycle and on foot, flashlights in hand. Kids chase each other, friends catch up on the latest, and everyone keeps an eye in the direction of California, 4,300 miles away.

Right on schedule (ICBMs are very precise) the clouds light up from within like a flash of summer lightning, and a cluster of bright meteors begins raining down from the sky. Excited children count the streaks out loud: "One! Two! Three! Four!" (They never know how many multiple reentry vehicles they'll get to see.) The missiles—minus their nuclear warheads, for this, of course, is only a test—fall silently into the ocean some 10 miles from shore, and as suddenly as they began, the fireworks are over. After leisurely good-byes, the Kwajalein families head home, flashlights bobbing off into the humid night.



A signpost makes clear just how remote Kwajalein is. The largest island in the atoll, it's home and workplace for nearly all of USAKA's 2,500 residents.

Part of the Marshall Islands, Kwajalein Atoll is a 160-mile-long chain of coral islands encircling a 1,000-square-mile lagoon—the world's largest. It's also one of only three places in the world currently allowed by treaty to track and receive incoming intercontinental ballistic missiles. Several times a year, the

"Unaccompanieds" live in barracks-style apartments, while families occupy trailers or small houses tucked among the island's few trees.

Air Force randomly selects an ICBM and its crew from one of eight U.S. locations, sends them to Vandenberg, and lets fly toward Kwajalein as a test of missile reliability, accuracy, and crew readiness. The unarmed Minuteman III that I watched fall from space last May had been plucked from a silo at

Montana's Malmstrom Air Force Base, but it could just as well have been from Warren AFB in Wyoming, Minot AFB in North Dakota, or any of five other bases. Altogether, nearly 600 ICBMs, each tipped with multiple warheads, are poised at any moment to launch from silos in the continental United States.

The U.S. Army Kwajalein Atoll—"US- AKA" to the Pentagon, "Kwaj" to its 2,500 residents—is a holdover from another era, a tropical outpost of the cold war, standing ready since 1959 to prepare for nuclear Armageddon. The Big One has in fact already dropped very near here. The 1954 Bravo hydrogen bomb test, at 15 megatons this country's largest ever, was conducted only two atolls away, near Bikini. It vaporized three islands. A much smaller underwater blast eight years earlier tossed the USS *Saratoga*, a 33,000-ton aircraft carrier, like a bathtub toy half a mile from its original position. B-52 pilots who dropped bombs over the Marshalls early in the Atomic Age reported watching water levels sink as lagoons got sucked up into the mushroom cloud.

The nuking has stopped, but the planning hasn't. Today Kwaj is at center stage in a revitalized and always controversial missile defense program, the remnants of the Strategic Defense Initiative of the 1980s. Two years from now, a high-stakes, full-up test from US- AKA will go a long way toward determining whether the United States is technically able to put up even a limited shield against enemy missiles. The future of the nuclear arms race—and, not incidentally, of Kwajalein—hangs in the balance.

Reaching Kwaj from the eastern United States takes two full days, and at times during the trip I would have gladly signed up for the half-hour ICBM ride instead. One stop along the way is Johnston Island, a grim little spit of sand halfway between Hawaii and nowhere. Run by the Defense Nuclear Agency, this 625-acre outpost is where the United States disposes of its chemical weapons. White smoke billows from the incinerator as we wait on the runway. Residents are required to carry a syringe and a supply of atropine—an antidote for "nerve agents"—at all times in case

of emergency. Men can't wear beards or mustaches, because facial hair might interfere with donning a gas mask, also standard issue.

The guy sitting next to me is getting off at Johnston to help install a fiber optics system. I ask how long he'll be there. "Sixty days," he says with a brief, sad smile, and goes back to staring out the window. *My God, I think, what if Kwajalein is like this?*

The next day I'm bicycling around Kwaj on a rented one-speed (no private cars allowed, since there's no room on a three- by one-half-mile island for parking lots), and all worries about a wasteland have vanished. The place is your typical tropical paradise: crashing surf, swaying palms, turquoise water, and temperatures in the 80s every day—forever. To this the Army has added most, if not all, of the comforts of home: shops, open-air movie theater, school, hospital, church, library, restaurant, bar, golf course, fitness center, bowling alley. Young mothers jog with their toddlers through shady residential streets at the north end of the island, and for a moment you might think you're in some suburb of Miami or Phoenix.

Cindy Brewer, one of Kwaj's two public affairs officers, holds forth cheerfully on the Kwaj experience as we tour the island in a golf cart she's checked out for the day. Everyone else is on bicycles. "There's the weather guy," she waves as we pass. "The locksmith and the doctor," she laughs, pointing. "Everyone knows everyone here."

Brewer, who was a Navy merchant marine before becoming an Army civilian employee, and her husband Tom Dillon, a Raytheon contractor who's in charge of USAKA's small fleet of vessels, live with their 12-year-old daughter in a converted trailer, like many of the base's smaller families. Life here, she says, is "like being on a big ship, with dogs and children."

For some, it's not so easy. Almost all of USAKA's residents live on Kwajalein, the large island for which the rest of the chain is named. But after hours, there's no off-base to go to. "It's difficult on the introverts," says Brewer. "Some people land, take one look around, and want to get right back on the plane."

It's probably hardest on single personnel, the "unaccompanieds" who live

in bachelor dorms and make up most of Kwaj's American-born workforce. The pay is good, though, and since the employees living in the dorms receive meals and housing free, they can bank almost everything they earn and pile up money quickly. Pres Lockridge, Brewer's boss, who used to work for NASA in Houston, says it reminds him at times of an oil town. "I've seen guys bet \$1,000 on a pool shot," he says over a beer in the Yokwe Yuk (the Marshallese equivalent of "aloha") Club.

The atmosphere on Kwajalein is shorts-and-sandals casual, which is not to say people don't work hard. Along with one of the most sophisticated arrays of radars and optical sensors on the planet, US- AKA employees maintain an infrastructure of 834 buildings, an international airport with a 6,673-foot runway, three de Havilland Dash-7s, five Huey helicopters, and a harbor full of cargo carriers, ferries, a tracking ship, and a mini-submarine used (rarely) to fish reentry vehicles out of the water—all scattered among the atoll's dozens of coral islands. Colonel Scott Cottrell, Kwaj's crisp commanding officer, some-

Kwaj's harsh salt air (several times more corrosive than California's) makes it essential to cover radars with protective domes.





times wonders if he's running not an Army installation but a small country. Being the boss here, he says with a grin, is "the strangest job I've ever had."

It must have been even stranger in the heyday of the cold war. Back then airline passengers flying over the island had to lower their window shades and stow their cameras. Kids growing up here in the '60s knew all about cloak-and-dagger, not that they took it very seriously. As a joke, when phoning home to the States, they would first say "Hi, Brand X" into the receiver—the locals' nickname for the Russian trawler snooping offshore during missile tests.

You still need the Army's permission to get off the plane at Kwajalein, but things are a lot less hush-hush today. Russian spy ships hardly bother to make the long trip anymore. The fact that the atoll is hard to get to has always been one of its main advantages. The isolation means there's no radio interference, no shipping lanes, no light pollution, and no population in danger of being conked on the head with missile parts (the Marshallese who live on islands situated inside the missile range have agreed to clear out for all but a few weeks a year, when they can return to check on their homes and fish the waters).

And Kwaj's remote location makes

it ideal for more than just ICBM target practice. One lucrative line of work is space tracking for customers like NASA and the Air Force. From its position near the equator, Kwaj is the only site in the United States' global space surveillance network that can monitor launches from Asia. The giant radar dishes on the island of Roi-Namur, at the northern end of the atoll, track some 50 foreign launches a year—both the ones



Bicycles rule in a place where personal cars aren't allowed. Marty Sargent (below) stands inside the dome of a Super RADOT camera used to record the final moments of a missile flight.

that are announced and the ones that aren't, so Kwaj has to be on permanent standby in case an Air Force spy satellite spots a launch. "We get a phone call from Cheyenne Mountain [the Colorado site of the North American Air Defense Command], and we're on a 15-minute alert," says Cottrell.

In addition to tracking launches around the world, Kwaj also supports field testing of "theater missile defense" systems for protecting soldiers on the battlefield, a hot commodity in the Pentagon these days. Earlier this year, as part of a large operation called "Willow Dune," an upgraded Patriot interceptor fired from USAKA's launch pad on Meck Island shot down a Scud missile launched from nearby Aur Atoll. Willow Dune's performance was monitored not only by the plentiful hardware on Kwaj but by nearly every sensor that could be flown in from other sites. When the equipment started arriving for game day, recalls one resident, "C-5s darkened the skies."

Normally, these kinds of tests are

done in places that are easier and cheaper to get to, like White Sands in New Mexico or Eglin Air Force Base in Florida. But in the continental United States, you can only get so far away from cities, water skiers, and air traffic, which limits the type of testing that can be done. When it's "full envelope" tests you need, come to Kwaj, says Captain Jim Winbush, a range control officer at USAKA and one of only 25 uniformed Army personnel on the base. "We don't have to cut the corners out here," he boasts with a no-nonsense military air. It doesn't matter whether you're launching medium- to long-range missiles from Hawaii (2,300 miles away), medium-range missiles from Wake Island (680 miles), or short-range missiles from Aur Atoll (230 miles). Who cares? There's no one around. You shoot 'em and Kwaj'll catch 'em.

Or, more accurately, Kwaj will *watch* them: More than 40 cameras, radars, and telemetry antennas are scattered around eight of the 11 islands USAKA leases from the Marshallese government, with secure fiber optics cables running under the lagoon to link the whole network together. This wide dispersion of sensors, while it poses a logistical problem, is intentional. What one camera or radar misses, another might catch, particularly when the weather on Kwaj could well be different from the weather at the other end of the atoll, 50 miles away.

One recent addition is a new underwater hydrophone array for "scoring" missile impacts in the ocean. By triangulating on the sound a reentry vehicle makes as it hits the water, USAKA can give the Air Force a very accurate reading of how good its aim was. The hydrophones will replace the old scoring method: splash detection radars that record the 300-foot-high plume kicked up when a speeding reentry vehicle slams into the ocean.

Touring the island in our golf cart, Cindy Brewer and I pay a visit to one of the RADOT/Super RADOTs, which stands for "Recording Automatic Digital Optical Tracker." Housed in domes to protect them from the constant salt air, they look like little astronomical observatories. The Super RADOTs, are, in fact, "borderline celestial telescopes," says lead engineer Marty Sargent.

The RADOTs, Sargent explains, have lower resolution, and generally pick up incoming objects at an altitude of about 35 miles, just seconds before they hit. The more powerful Super RADOTs can track objects much farther out. Together, they return very accurate positioning data on the final moments of a missile flight, which they dutifully record on film and videotape.

The Super RADOTs are fully automated, but the regular RADOTs require a human operator to ride inside what looks like a cage. Since the pointing of the camera is "slaved" to a tracking radar, the operator inside the cage is never quite sure when the instrument will swivel wildly to follow a fast-moving target. The ride can get pretty rough.

But a Kwaj resident who's done it confided that what really got to him was the sonic boom from the reentry vehicles. "You can feel it in your stomach," he recalled. "That's when I realized Ground Zero's probably not a really fun place to be."

The tour finished, Brewer and I stand outside one of the Super RADOT domes, which glares a bright white on this steamy morning. It's low tide. Out on the reef an elderly Marshallese man is fishing in shin-deep water, or rather,

On Kwajalein, radars come in all sizes. Among the jobs this 29-foot dish handles is tracking radio signals from incoming missiles.

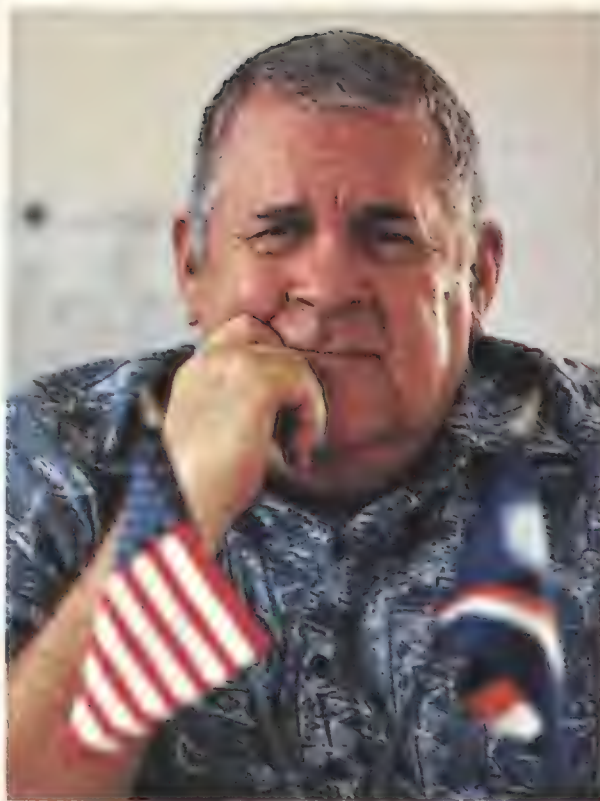


picking up stranded fish and plopping them in a bag.

Before being colonized in the 19th century by Europeans, the Marshallese were highly skilled mariners who developed sophisticated "stick charts" to read the wave patterns and currents between atolls (on such flat land, there are no mountains to use as landmarks).

Today the Marshallese live in an uneasy symbiosis with the Americans who occupy their land. Officially, the two governments shake hands and smile, talk about their "partnership," and refer to the Republic of the Marshall Islands as the "host nation." But spend a day on Kwajalein and it's easy to see who has the money and power and who's doing the dishes and cutting the grass.

The United States needs the Marshallese, and for more than just cheap labor. Colonel Cottrell, while briefing a visiting Air Force general, puts it bluntly: "Without the international partnership, there is no Kwajalein Missile Range." USAKA's 15-year lease is up in 2001, and though the United States has an option to extend it for another 15 years, the Marshallese have already said they'd like to renegotiate a higher rate than the current one, which is



Norm Smith worries about overcrowding on neighboring Ebeye (below), where the Marshallese population continues to swell.

about \$12 million per year.

Cottrell points worriedly to a briefing chart showing projected population growth on Ebeye, an adjoining island

that's home to about 1,200 Marshallese workers who ferry over to Kwaj every day. Ebeye, says Cottrell, is already "very, very crowded," with an average of 14 people per household. In 1952, 30 people lived there. Today there are 12,500 and the number is expected to swell to 20,000 by 2000. "This could get bad," he says, flipping the chart.

Norm Smith, who heads the USAKA office that handles relations with the host nation, sits behind a desk with a Marshallese and American flag on it. On the wall are pictures of his kids and his Marshallese wife. Smith looks to be in his 50s and has a contentment about him. He has spent nearly 40 years kicking around the Pacific, including five and a half years living with his family on an island with no electricity or running water. Having tried the subsistence life, he says he wants for little any more.

I expect a PR spin on U.S. relations with the Marshallese, a list of the many things the Army—and even individuals living on Kwaj—are doing to improve life for the islanders. But he gives me the rest of the story. He worries that the social fabric on Ebeye, strained by overcrowding and poverty, is unravel-



ing under such Western influences as television and fast food. It seems unavoidable, this submergence of the native culture, given the dominating presence of the Americans. "There's nothing that really can be done," he concludes resignedly. "Either they're going to change or else."

The big tracking radars on Roi-Namur are USAKA's pride and joy, the money instruments that together keep watch over a wide swath of the radio spectrum. Roi, as the residents call it, is a 30-minute trip by airplane from the main island. About 350 people work there every day, 200 of whom spend the night, so a Dash-7 commuter aircraft makes six or seven daily runs between Kwajalein and Roi. During my flight, people chat and read like commuters everywhere, except that out the window is a dazzling emerald lagoon rimmed by lush islets with bone-white beaches.

Roi is more overgrown than Kwajalein, and less crowded. History has yet to be paved over here, and you can still see, tucked back in the vegetation, concrete bunkers abandoned by Japanese soldiers during World War II. Both Kwaj and Roi saw heavy fighting in 1944, when U.S. forces landed there to dislodge the Japanese from the Marshalls. Residents still routinely find live ammunition and, occasionally, the bones of Japanese soldiers.

Chatting about Roi's history inside an air-conditioned office building, Kurt Schwan digs into his desk drawer and shows me a corroded bullet case he found in his driveway. Schwan, one of 30 employees sent here by the Massachusetts Institute of Technology's Lincoln Laboratories (the scientific advisors for Kwajalein's radars), is MIT's deputy site manager. He gives me the rundown on Kwaj's tracking capabilities. TRADEX and ALTAIR are low-frequency dish radars that can pick up incoming objects as soon as they come over Kwajalein's horizon, at a distance of about 2,400 miles. ALTAIR, the larger and more powerful of the two, does a lot of work for the Air Force, helping to update its catalogue of satellites, space debris, and other orbiting objects. It has tracked everything from an astronaut's glove to the Galileo Jupiter



spacecraft, which it followed for a record 73,000 miles before being yanked away for another job.

Because ALTAIR plays a key role in monitoring foreign launches, maintenance has to be scheduled carefully to minimize down time. But it can't be postponed indefinitely: The moist, salt air causes rust and corrosion. Other structures are just plain old. Roi's power plant, for example, is "much in need of replacement," laments a radar technician as we drive past. It looks it. Spare parts are thousands of miles away, and those that can't be machined on site have to be ordered well in advance. With such a small workforce, everyone

learns to fix his own equipment, and everyone doubles up on skills. "Our engineers use soldering irons, and our technicians look at drawings," says one USAKA employee.

ALCOR and MMW, the other two large radars on Roi, operate at high fre-

Kurt Schwan (right) is one of about 30 scientists assigned to Kwaj from MIT's Lincoln Laboratories, which runs sophisticated radars like ALTAIR (right) and TRADEX (above). Other Kwaj residents sometimes refer to MIT detailees as "the radar wizards" or simply "the smart guys."



quencies, which enables them to image objects in space. MMW can detect details as small as five inches, which makes it particularly valuable to the intelligence community. As Captain Winbush puts it, "ALTAIR just tells you [the object] is there. MMW tells you what it looks like."

All four radars are booked solid, and lately business has been good. But the pressure to cut costs is mounting, says Schwan, and he's already exploring ways to replace human operators with automated systems to reduce the number of people making the daily commute from Kwaj to Roi. Schwan, who is friendly and easygoing, doesn't relish becoming Mr. Downsizer, but he says, "It may be that's my sole job in the near future."

He likes living on Kwaj, enough to have returned for a second tour, but he will be happy to get back to Massachusetts. Generally, he says, "We don't like our [MIT] people to stay out here beyond five years." Any longer and the technology can pass them by. "You come out here to get a lot of experience with real systems," he says, then adds with a laugh, "People go crazy out here too."

Back on Kwajalein, I'm shown around the new mission control center, which is as modern as Roi's power plant



USAKA's new Mission Control (above) looks to the future of ballistic missile defense tests, while an abandoned radar called the DCCB (below) is a reminder of past political indecisiveness over nuclear defense. The radar was scrapped by Congressional order in the 1970s before it ever went online. Today it's a warehouse.

is dilapidated. Had I been in this darkened room instead of at the island's northern end during last night's fireworks, I would have seen a buzz of activity, with technicians calling out telemetry and radar readings coming in from sensors all over the atoll. Today, though, things are quiet, the chairs empty, the color monitors and overhead displays frozen on the same unclassified (for my sake) and unintelligible (to me) numbers and letters. It looks every bit like Hollywood's vision of Mission Control.

Outside in the lobby, I stand with Jeff Beckley next to two dull black cones with silver tips. These are ICBM reentry vehicles—delivery packages for nuclear weapons—and they're about as tall as we are. They look like overgrown traffic pylons, only more sinister.

Beckley, who attended high school on Kwaj in the late '60s and early '70s

and eventually came back to work here, is now the control center's operations and planning chief. He seems surprisingly open in discussing what I had assumed were secret devices, so I ask what he can't tell me. A few things, he says: the reentry vehicles' precise spin rate, the composition of the ablative coatings that burn off in the atmosphere. "The real secret in reentry vehicles is in the strength of the nose tip," he says.

One of the pylons in the lobby is a "city buster," the other a "silo buster," which takes out enemy missiles before they leave the ground. Beckley shows me the difference. The city buster has a flat antenna stuck to its side for receiving radio signals, which would instruct it to explode while still above the target, damaging a broader area.

No one would tell me exactly how accurate the silo busters are. Kwaj's new hydrophone scoring system, if that's any indication, is designed to pinpoint a reentry vehicle's splashdown to within 18 feet. "Glory trips," as the Air Force grandiloquently calls its ICBM tests, have pretty well established the United States' ability to launch nuclear missiles with deadly accuracy. We know how to play offense. So how good is our defense?

That question will likely be answered in the next few years as USAKA continues to work on its bread-and-butter project: National Missile Defense. NMD's mission is to protect the U.S. civilian population against incoming ICBMs, and its success relies partly on tests now under way at Kwaj. For largely political reasons, those involved with NMD are pursuing a cautious "three-plus-three" approach to development. Test for three years, get the technology ready to go, then make a decision in 2000



The nuclear family, Kwajalein style: Buck Blackwell and his wife Pam have lived on Kwaj for almost two years. She's building a radar to track incoming warheads; he's testing an interceptor to shoot them down. Below: For some USAKA employees, a helicopter is the only way to get to work.

U.S. ARMY



whether to deploy a missile defense shield within three years, based on an updated assessment of the threat. Meanwhile, treaty obligations must be followed to a T. Longstanding, delicately crafted international agreements strictly limit the numbers and types of radars and interceptors each nation could deploy for an operational missile defense

system. They also place some restrictions on testing, such as limiting the number of test interceptors to 15.

Kwaj has faced these restrictions before, because NMD concepts have come and gone. In 1984, in the full flush of

Reagan-era Strategic Defense Initiative—"Star Wars"—funding, the Army's Homing Overlay Experiment "hit a bullet with a bullet," demonstrating for the first time that a missile could collide with an ICBM reentry vehicle in space. Seven years later, as SDI was winding down, the program did something even trickier. The Exoatmospheric Reentry-vehicle Interceptor Subsystem, fired from Kwajalein's launch pad on Meck Island, repeated this "kinetic kill" even when the RV was hiding in a cluster of decoys.

The current NMD architecture would also use an exoatmospheric kill vehicle as the interceptor. The high-velocity hit would take place in space, about 60 miles up, within 15 minutes of an enemy missile's launch. Infrared-sensing satellites would first pick up the target in its boost phase, when the rockets were still firing. Upgraded early-warning radars on the ground would next pick up the track, then hand it off to a single powerful ground-based radar located in the same place as the interceptors. That place will most likely be Grand Forks, North Dakota, but prototypes of both the interceptor and the radar are being built and tested today on Kwajalein.

Buck Blackwell is in charge of field testing for the exoatmospheric interceptor. His wife, Pam, is field office project manager for the ground-based radar prototype. They moved from Huntsville, Alabama, 18 months ago and now live in one of Kwaj's nicer two-level houses with their children, ages nine and four. Affable Southerners both, they seem as unpretentious a couple as you'd ever meet. And together, they're responsible for half the nation's future nuclear defense system.



I ask Buck Blackwell if that sometimes seems a little, well, weird. He laughs. "Yeah, we've talked about it a little bit, and it is kind of an interesting feeling," he says. But mostly he's too occupied with the technical problem *du jour* to think much about it. Only when generals come visiting from Washington or when he sees one of his tests reported on the national news does he think, *Whoa, this is kind of a big deal here!*

We're talking by phone a couple of months after my visit to Kwaj, and a few weeks after his interceptor program has scored its first big success. In June, an assembly of refurbished second- and third-stage rocket motors taken from a Minuteman II lifted off from Meck with a cooled infrared sensor onboard, just 20 minutes after another Minuteman launched from Vandenberg carrying nine target objects, including a reentry vehicle. The sensor picked out the "bad guy," as Blackwell calls it, from the cloud of decoys, which in real life would include spent rocket parts and other assorted radar-fooling chaff. A competing sensor design will fly this winter.

The sensor tests will be followed next year by several intercept tests in which exoatmospheric vehicles will try to identify, catch, and destroy real reentry vehicles from a wide range of approach geometries and at speeds of several

miles per second. Then, sometime in 1999, will come the NMD program's full dress rehearsal—with satellites, ground-based radars, communications and battle management links, the works—before Congress and the White House decide whether to deploy an operational system.

With so few chances to test, a lot is riding on each shot. Blackwell is breathing much easier after the June success, especially considering what happened last January. The launch crew on Meck made a mistake, somehow missing a faulty power setting, and when it came time for the rocket to lift off, nothing happened. Since the target missile had already launched from Vandenberg, the whole event was a complete waste. The error cost the program about \$50 million, set back an already tight schedule by several months, and cast a pall over the village of Kwaj.

"It was tough," Blackwell admits. "We had a lot of hours going into that [test] and it was pretty brutal." It was especially hard, he says, on the Boeing team that had built the sensor. Having already spent several months on Kwaj, they had to pack up, go home, "then come out here in the summer and do it all again." Before the second flight, "I was eating Roloids and not sleeping much for two weeks," says Blackwell. But it went smoothly, and now he can get back to his regular routine.

His main worry now is not having more tests, "more bullets to shoot at." Even the generals in charge of NMD admit that their program is woefully short on real, live flight testing. Critics have also seized on this flaw, and they've picked up on others too: Even if it works perfectly, the NMD system will be like wearing half of a helmet, because it can protect against only 20 or so missiles, a limit dictated by the number of interceptors the Anti-Ballistic Missile treaty allows. It offers no defense against a full- or even medium-size nuclear assault—just an accidental launch from another nation or a handful of nuclear, biological, or chemical weapons thrown our way by some rogue state. And deploying such an NMD system could possibly spark a whole new offensive arms race, the perpetual fear of ABM opponents.

Nagging questions like these are part of the reason the deployment decision is still very much up in the air. Meanwhile, Buck Blackwell, whose job it is to get the system ready anyway, covets the half-dozen or so "offensive" missiles Vandenberg lobs toward Kwaj every year, and he fantasizes about scrimmaging against them. "The Air Force flies these things in here all the time, and we're supposed to be able to knock them down, so..." Right now, shooting down Air Force property is just an idle thought. There's no official approval for such a plan, and no money. But a guy can dream.

Pam Blackwell, who's building the new ground-based radar prototype over on Kwajalein, hopes her radar will help her husband's interceptors get the job done by feeding precise tracking and discrimination data on the incoming targets. Blackwell and her colleague Danny Pollard, who has recently arrived from Huntsville, show me around the construction site, which is on an isolated jut of land away from the houses, the stores, the airstrip, and even the other antennas.

When it's finished later this year, the radar will be among the world's most

U.S. ARMY



Each morning 1,200 Marshallese workers from Ebeye make the short ferry trip over to Kwajalein, where only U.S. citizens are allowed to live.



U.S. ARMY

Meck Island is the atoll's designated rocket range. There's room for a launch pad, blockhouse, and very little else.

sophisticated. Instead of a dish, it has a flat "phased array" of some 17,000 transmitting and receiving elements. It can scan both physically (by turning on its mount) and electronically, which is about as deluxe as radars get right now. "It's the latest, greatest technology," says Pam Blackwell, able to "acquire, track, and discriminate several objects simultaneously in real time. The other radars [on Kwaj] can't do that."

Even as the Blackwells build, their home country is undecided whether it wants to use technology or diplomacy to prevent nuclear annihilation. Most Americans might think that such worries are an anachronism, yesterday's crisis. But on Kwaj, they prepare every day for a strange kind of war the world has never seen, and may never yet.

Ask the Marshallese, though, what a nuclear war would look like. They still feel bitterness about what happened

here in 1954, when the United States detonated the hydrogen bomb Bravo, which had 1,000 times the power of the Hiroshima bomb. Before the test began, the wind shifted, carrying fallout from the explosion toward Rongelap, where the residents of Bikini had been moved. Skin burned, hair fell out. Marshallese children developed thyroid tumors. The Marshallese still contend that U.S. forces knew about the wind shift and proceeded with the test anyway, and in fact were deliberately experimenting on the native population—a controversy the U.S. Department of Energy was unable to settle in an exhaustive 1995 report. Decades later, the two nations are still locked in a cycle of lawsuits, medical tests, environmental assays, and reparations payments.

On Kwajalein I run into a young Baptist missionary recently arrived from Alabama ("still wet behind the ears," he jokes). He can't be more than 21 years old, and he's living on Ebeye with his wife and two kids. He asks if I'll be including the Marshallese in my story, and he suddenly turns passionate. "These

people are the real heroes," he says. "They're the ones who made the sacrifices that eventually brought the Russians to their knees." His words remind me that occasionally the cold war was more than just a political construct—that it sometimes had, and still has, genuine dangers.

Unlike most of the Americans who live on Kwaj, Hal Lucas has seen a real war zone. Before moving here a few months ago to pilot Dash-7s on the commuter runs to Roi-Namur, he was stationed in Hungary and flying RC-12 signal intelligence aircraft over nearby Bosnia. He lived in a tent for 13 months. His photos, all snow and ice, look as bleak as you might expect.

One morning on the way to breakfast, I pass him bicycling along the road. We stop to talk, and I ask if this feels like paradise after Bosnia. "Oh, it's a tremendous paradise!" he beams, gesturing appreciatively at the surf, the coconut palms waving in the breeze. "Pretty tough place to live, huh?" he laughs.

Pedaling off, he looks like the happiest guy on the island. —



An exhilarating deep sky viewing feast.

Sky Raves

by Frank Kuznik

Illustrations by Richard Thompson

All-night
star-gazing
from a
mountaintop.

Across the expanse of high desert atop a remote hill deep in Oregon's Ochoco National Forest, a brisk wind, chilling even in late August, carries a coyote's howl. As twilight's glow wanes, the only other sound comes from more than 500 amateur and aspiring astronomers as they set up camp for the Oregon Star Party.



When night descends here, the sky is one of the darkest in the country. The constellations seem to disappear among a dazzling explosion of stars. The Milky Way stretches from horizon to horizon, in a swath so deep and rich that its spiral arms can be discerned.

Over three nights, a virtual forest of telescopes sprouts from this otherwise empty prairie, reaching eight, 10, even 16 feet high. The 'scopes are covered with protective shrouds by day. Sunset brings a crackle of anticipation and a flurry of activity—layers of warm clothing go on, the shrouds come off, and

tables, chairs, ladders, star charts, and other paraphernalia are carefully arranged around each telescope. Darkness finds the faithful perched at their eyepieces, searching for objects invisible anywhere else, yelling like game show contestants when they find one.

"There's the Dumbbell nebula!"

"You can see Cassini's division in the rings!"

"Hey, come look, we've got the double cluster!"

"Party" is something of a misnomer for the event, which mixes elements of a camping trip, science fair, and college all-nighter. If it all sounds a bit geeky... well, that's because it is. But only from a distance. To actually stand under the full, undiluted darkness of the heavens and track distant objects through a succession of high-quality telescopes is a truly breathtaking experience, the kind that keeps people coming back, year after year.

Star parties are a longstanding summer tradition in the astronomy community. Stellafane, the annual gathering of telescope enthusiasts in Vermont, started in 1936. The Texas Star Party is 19 years old; Table Mountain in Washington is 18. And those are just the large, public events. Some star parties, like the Okie-Tex Star Party, which *Astronomy* magazine ranks among the top ten of such gatherings, combine telescope viewing with other activities, like swap-meets, cookouts, fishing, boating, and horseback riding.

The first OSP was held in 1988. Since then, the number of stargazing socials has grown enormously and so has the number of people attending them. There are now dozens of star parties across the United States every year, as well as in Canada, Europe, and Australia. They go by a variety of colorful names—Star Stare, Starquest, Astrofest, Astroblast, Gateway to the Universe—and are equally diverse in character and locale. Some are family-oriented outings close to town, with a glut of vendors and daytime activities; others seek distant and primitive settings, trading comfort for the quality of the skies.

The Oregon Star Party, about 200 miles from Portland, is out on the rugged edge of the spectrum. The nearest water faucet is 25 miles away, and 14 portable toilets service the entire crowd.

Two small catering trucks provide an evening meal and coffee and sandwiches during the night, but otherwise it's a battle against the elements—desert heat by day, frigid temperatures at night, dust devils, storms, and "the landscape from Mars," as the Ochoco site is known. Newcomers are warned of the "dammit bushes," ubiquitous sagebrush notorious for tripping people up in the dark. The most notable landmark is a tall, dying pine tree, scarred by lightning during a storm that hammered the 1993 party, blowing down tents and literally shaking the ground.

In spite of such privation, more than 400 skynuts return every year, along with 100 to 150 "newbies," or novices. "There's a remarkably large number of brand-new people coming to these things," says Richard Berry, former editor of *Astronomy* magazine and a veteran of the star party circuit. "It's not just the hardcore anymore. For a lot of people, this is the first thing they've done in amateur astronomy."

Star parties offer an excellent opportunity to learn from experienced stargazers, who are amateur only in the sense that astronomy doesn't earn them a living. Many have an encyclopedic knowledge of the heavens, as well as some great equipment—thanks to the development of low-budget, big-mirror reflecting telescopes pioneered by John Dobson, an amateur astronomer famous for popularizing astronomy by creating home-built 'scopes that are easy to transport and set up. Dobsonian telescope mountings are simple box-like cradles often built from plywood. Many Dobsonian telescopes are made with home-ground mirrors mounted in simple tubes. Also present at OSP were compact, high-powered commercial models, all evidence that deep-sky viewing has moved out of the observatories and into fields and backyards.

Most star parties—and astronomers of all types—favor reflecting telescopes, which use large concave mirrors to collect as much light as possible from distant, faint objects. Other telescopes—refractors—use a system of lenses to magnify objects and provide advantages in resolution, but they are generally much more expensive, especially in large models. "I remember when I got my first telescope, an eight-inch re-

flector," recalls Ray Hinea, a Washington state prosecutor and OSP organizer. "That was 17 years ago, and I thought I was walkin' tall. But that's nothing compared to the 20- and 24-inch 'scopes you see up here now." (For reflecting telescopes, size is expressed as the diameter of the primary mirror.)

Hinea looks at a row of Dobsonian telescopes arrayed like cannon across the hilltop. "For an amateur to possess that type of power 10 years ago would have been unthinkable," he says.

"Yeah," laughs John Cart, another OSP organizer. "It would have been like having your own atomic bomb."

Power does not come cheap. A telescope can cost as much as \$15,000, which is why many amateurs make their own. Mel Bartels, a lifelong space enthusiast from Eugene, built a nifty 20-inch Dobsonian for \$1,000—and wrote the software for a computer drive to point it. Steve Swayze, an OSP veteran and well-known amateur telescope maker, arrived with a monster 40-inch Dobsonian in tow, which he built for \$7,000. At one time the largest privately owned

telescope in the country, it went up like a carnival ride and attracted a long line of excited viewers, even when the sky was clouded over.

But through either a huge telescope or a simple pair of binoculars, the attraction is the same—direct access to space, a visceral connection with the wonders of the universe.

"If you're interested in outer space, the only way you can get to it is either through the information base compiled by professionals or by looking through your telescope, which is a link from you to the sky," says OSP president Chuck Dethloff.

That passion was what brought Bill Jensen, an experienced amateur astronomer, all the way from Springfield, Virginia. "Even though I was here last year, I forgot how amazing the skies are," he says, grinning. Jensen was up until dawn the first night, sampling the view on Dethloff's 24-inch Dobsonian. "I saw galaxies I've never seen before. And M15 [a globular cluster] was like a religious experience."

Margaret McCrea, a legal secretary

from Portland, had zero experience in astronomy before an outing to see the Perseid meteor shower just two weeks before the OSP. "I was so jazzed that I got my car fixed and my binoculars and sleeping bag cleaned, and got my butt out here," she says. She arrived without knowing where to locate the Big Dipper but spent an inspirational first night touring the telescopes. "Saturn makes life worth living," she declared in the morning. "This is bringing me as close to heaven as I can get—in a couple of ways."

That sense of wonder strikes with the first glimpse through the glass. The planets, mere points of light to the naked eye, become luminous, with details like the bands on Jupiter and the division in Saturn's rings alternately blurring and sharpening in the night air. Patient searching along a prescribed path from a prominent celestial marker, such as the Square of Pegasus, leads to more distant objects like the Andromeda galaxy (M31), a galaxy much like ours that becomes a beautiful swirl of light in the eyepiece. Even more remote galaxies and nebulae appear as no more than gauzy wisps, leaving the viewer stricken with "aperture fever"—the insatiable urge for higher power and better resolution.

The pros have seen these objects many times, so for them the thrill lies in a particularly transparent night, the seasonal appearance of a favorite object, or the chance to try out new equipment. Viewing habits vary widely from person to person. "I'm an extremely casual observer," says Swayze. "There are thousands of objects out there to look at. I just put the telescope on whatever I feel like looking at at the time." Others methodically work their way through various listings, including the Messier catalogue, a compilation of just over 100 non-stellar objects such as nebulae, galaxies, and clusters classified by their "M" number. The New General Catalog (NGC) was first produced in 1888 and also lists nearly 8,000 objects other than stars.

As part of the registration packet, the OSP provides listings of personal favorites compiled by veterans of the event. Among the suggestions offered by Howard Banich, for example, was NGC 253, a spiral galaxy in Sculptor:





A monster 40" Dobsonian

"This incredible galaxy is located rather low in the south and can be disappointing unless the conditions are close to perfect," he warns, but adds that the galaxy is large, sharply tilted, and loaded with detail, and under the best conditions "will knock your socks off." Several faint Milky Way foreground stars add to the visual magic of this memorable galaxy.

Most star parties take advantage of exceptional skies to search for objects thousands or millions of light-years away: M57, the ring nebula in Lyra; NGC 6992, the veil nebula in Cygnus; or NGC 7317-20, a quintuple galaxy in Pegasus known as Stephan's Quintet, named after M.E. Stephan, who discovered them in 1877. Experienced observers tend to eschew the planets, with the exception of Saturn, which is equally fascinating on the 10th or 10,000th viewing.

Planets may be fun, but Jupiter on a good night can blow out your vision like a flashbulb. Optimal night vision is an obsession among OSP veterans, who wear sunglasses until well after sundown and have earnest discussions during the day about the physiology of eye adaptation. The only light allowed

after dark is that of red-filter flashlights, helpful for reading star charts but useless for finding your way around the 80-acre site. If a car door opened after dark triggers a dome light—even hundreds of yards from the viewing field—there are immediate cries of "White light!" as if the blitzkrieg is on.

"Yeah," says Dethloff, "it's like, 'Get a rope,' you know, as in, string 'em up!'"

Though it seems anal-retentive at first, this attitude quickly makes sense. For one thing, there's no point in driving hundreds of miles into the wilderness just to replicate the light pollution of the city. Given time, the eyes will adjust to starlight. It may be an odd sensation to carry on conversations all night with people you can't see or often even identify. But after a while, moving between the telescopes, tent, and coffee truck becomes perfectly manageable.

Newbies expecting the large, colorful objects that appear in popular photographs are often surprised to find them reduced to fuzzy smudges in amateur telescopes—and to see the inordinate excitement that such images create. But for the experienced amateur, it's a given that no real-time view—even

through Swayze's 40-inch telescope—can match sophisticated, time-exposure astrophotography.

"The greatest challenge and enjoyment for me is the hunt," says Rebecca Gee, who helped organize OSP. It's you against the DFOs—dim fuzzy objects. "I get a wonderful feeling of accomplishment tracking down a 14th-magnitude object." (That's about 1,600 times fainter than the dimmest star visible with the naked eye under the darkest possible sky.)

And real-time viewing is a critical part of establishing that link to the stars. Yes, you can see better images in books or on the Internet—but that would be a vicarious experience.

"This is the original, right there in front of you," explains Bartels. "I think if people could go out and dig for *T. rex* skeletons like we can look at the stars, you'd see enormous 1,000-person archaeological digs. Obviously they can't, but anyone can get a 'scope and look at the skies."

This year's OSP was blessed with two nights of superb viewing, with treats like the Orion nebula and M33, a spiral galaxy, appearing at 4 a.m. The third night clouded over, and the party broke up the next morning amid clouds of dust raised by departing campers and trucks, with lingering clusters of converts savoring the high.

At the crest of the hill, Swayze, Dethloff and his wife Judy, and a half dozen others were already settling in for another evening. The stars weave a spell not easily broken; soon night would return and the show would begin anew. ➔



Letters From the Front



An American pilot on the front lines in France gives an intimate account of the Great War.

On October 26, 1917, a 24-year-old graduate of the U.S. School of Military Aeronautics boarded the S.S. Manchuria in New York and sailed for Europe and the world war in first-class accommodations "with only officers and aviation students."

Lewis Clifford Plush, a California native, soon wrote to his parents from "Somewhere in France, Nov. 19, 1917: Our first touch of real army life came when we were sent to a so-called Rest Camp in England. I suppose it may be a place of rest for a soldier who was used to trench life, but for our bunch, who had been eating five or six course meals and sleeping in good soft beds on the boat, we couldn't understand where the rest part came in."

Plush was appointed to first lieutenant in the Aviation Section, Signal Reserve Corps, on May 21, 1918. On August 28, he was assigned to the 2nd Pursuit Group, 49th Aero Squadron of the American Expeditionary Force, which had just made its first patrol over the lines on August 16. These letters and photographs tell the story of World War I through the eyes of a young man who later wrote, "Certain pages stamp their impression on the memory that can never be erased and flash at unexpected times in the mind, living again the strange chapters of an artificial existence."



France

February 10, 1918

Dear Father and Mother,

I just came in from the flying field where several of the cadets are taking their first solo flight. The first trip alone is always a great event and furnishes plenty of thrills and amusements for the others on the field.

One fellow, in taking his first flight alone, had great difficulty in making a landing. He circled around once and tried to land. He missed the field by a quarter of a mile. He made another circle and tried it again. This time the field was so crowded with machines that he was afraid to try it. The next time he dove at the ground at a steep angle, hit on his wheels and bounced up in the air about fifty feet. He opened his throttle and made another circle. We thought perhaps we would have to shoot him down to keep him from starving to death up in the air. He made three or four more attempts and finally made a good landing. We found out afterwards that he had run out of gasoline and had to come down.

Since this incident took place, I have heard rumors of a very important invention. It is military information of a strictly confidential nature. I have been unable to secure any detailed information but this much I know according to the rumors: a biscuit gun is being designed to shoot biscuits to starving aviators who are unable to land.

You know what happens when an auto gets loose by itself and goes tearing down a street or jumping sidewalks? Well, try to imagine what a runaway airplane can do. Such a thing happened near here some time ago.

Engine trouble forced the pilot to make a forced landing near a little village where airplanes are an unusual sight. The whole populace turned out to welcome the American visitor. The pilot repaired his engine and picked out half a dozen sturdy peasants to hold the plane while he started the engine. He forgot and left the throttle about half open. The engine started with a bang and roar. The peasants ran for their life and left the plane to take care of itself. The plane chased the pilot. Then the pilot chased the plane. It performed remarkable feats all by itself. It started directly for a group of frightened peasants, swerved to

one side, chased a dog for a hundred yards, jumped a ditch, and started up in the air. It banked to one side and barely missed a corner of a stone wall and smashed squarely into a large tree. An airplane without a driver can never be trusted. It is apt to do almost anything.

Funny incidents and incidents that are not so funny happen on the field every day.

With Love, Lewis C. Plush
U.S. Air Service
American Expeditionary Force,
France, Via New York

April 1, 1918

To amuse myself and to use in case of an emergency I compiled a set of student rules for simple aviators—no, I mean a set of simple rules for student aviators:

To Descend: Cut the motor, peak, and pray.

To see if the Way is clear for Landings: Unlace your shoe and tie the stick in place. Then climb out on either wing and take a good look around.

To Land to the Mark: Get directly over a given point. Head the machine toward the point and hold her there until the ambulance comes.

To Land Safely in a Forest: Pick out a soft pine tree and head for it.

To Land in a River with Minimum Splash: Bank the machine and ease her in wing first.

To Land Safely on House-tops: Wait



Plush's Distinguished Service Cross was awarded in November 1918.

En route to France and adventures unknown (below).





Above: A mangled Avro 504 bomber.

Seaplanes were pressed into coastal-patrol service, searching for submarines. Below: A French Tellier returns to its hangar.



until the occupants are visiting relatives.

To Determine whether a Town is Inhabited: Drop a piece of limburger cheese on it.

To Have a Long and Happy Life: Get in some other service.

June 23, 1918

I have moved again, but this time only a couple of miles. The greatest feature of this camp is the meals. Just finished supper a few minutes ago and do not see how one could wish for a better meal. Of course, it was a Sunday dinner and perhaps a little more than usual. We had roast veal, creamed potatoes, green beans, cold cabbage, asparagus, generous slices of raisin pie, about an inch thick, tea, white bread, and butter. Of course,

we have to pay for it ourselves, 50 francs a week, but it is sure worth it.

I think I told you before that I wouldn't be satisfied until I was driving one of those small fast scout planes. Yesterday I had about twelve trips in the very type of plane that I had been working for ever

since I landed in France. It is certainly a pleasure to skim swiftly through the air in one of these small, delicate, and sensitive machines that make you feel

that you and the plane are one.

Vassar and Richards insist on having a feed before we get into our bunks so I will have to do my share of it. We have a closed corporation, as it were, for the three of us, when it comes to this line of duty. Vassar has had a Heintz plum pudding on the stove heating in hot water for about three hours, and Richards is insisting that I open my can of pineapple right away.

July 18, 1918

I am still at work here at Cayeux but by the time you have received this letter I will be elsewhere. I suppose you think that I am like the flea that made the Irishman famous—"Here he is and here he ain't." I am here now, but now I have moved again, is all I have been doing for the past few weeks.

We are fairly comfortable here now with the exception that our beds are not regulation for the best hotels. Four boards nailed together and laid across two short sawhorses may be all right if you like it, but I prefer the usual bunks made by stretching a piece of burlap between two beams.

I neglected to bring a mattress along with me and the combination of my four blankets and the four boards is not the best. The second night I moved out on the grass under a big pine tree. A tree toad on a limb just above my head kept up a loud serenade and almost busted himself in an effort to keep me awake. The sand fleas soon discovered me and called in all their friends to enjoy a great repast. By the time I had become used to the tree toad and had given up all hope of ever tiring out those elusive fleas by chasing them from spot to spot, it began to rain. Not an ordinary rain, but one of those summer showers that turns a cloud upside down and pours it all out at once. I was glad to use those boards again and—well, boards are not so bad after all.

August 17, 1918

"Be ready to leave camp in one hour" was the unexpected order I received this afternoon as I jumped out of my plane after a period of combat work. At exactly that moment my training was over, as



far as aviation school was concerned, and that I was now a chassé [pursuit] pilot ready for the front. No more would I combat with camera guns and shoot at targets that could not shoot back. The guns of the future will spit lead and the targets will return shot for shot.

And where am I now at this particular moment? I am on the Paris Express with two others traveling under the same orders. We are going to stop at Paris for a day and look over the city again. Will write when I reach our destination, as this Frenchman persists in using my shoulder as a pillow and his snores flavored with garlic are more than I can stand.

September 1, 1918

For the first time in a year I really belong to an organization, a squadron, a group that I can call home. I have been officially adopted into the family of the 49th Aero Squadron.

We are treated so well here it seems almost like a reward for surviving the long training period. When I was shown the room that was to be my quarters, with the comfortable recreation room just across the hall with its piano, phonograph, comfortable chairs, etc.; when I had the first meal in the officer mess hall; when I was assigned a new plane to be my own with two fine mechanics to keep it in order; when I was treated in this manner it almost made me a little suspicious, because it was such a sudden change that it looked like the "fatted calf" proposition.

The Germans have already called and dropped their calling cards but I rather snubbed them. At their first knock I grabbed my tin hat, jumped through the window, and crawled into the dugout

with the rest of the bunch. I know enough about German bombs and the falling shrapnel from the anti-aircraft guns to overcome the brand of American curiosity that wants to see it all. I could hear enough to satisfy my curiosity: that weird screaming of the flying shrapnel and the whistling of a falling bomb in the middle of the night is better music than ragtime for the acceleration of foot movement of a midnight frolic. Pajamas and shoes and a tin hat are the usual costumes worn by the most elite of the officers on these festive occasions.

I have been fully introduced to the

duties of a pursuit pilot. I am as proud of my plane as a young rooster is of his first crow. It is of the latest

Nov 23 1918
Dear Father & Mother.
I am enclosing a few pictures

A chain gang gets a de Havilland D.H.4 going (above). The 4s served as bombers and observation aircraft.

A squadron pilot and mechanic proudly pose with a Spad XIII (below), which Plush describes as "the latest chassé type, powerful, swift, and flies like a thing alive."

chassé type, powerful, swift, and flies like a thing alive. The next thing to do is find a good name to paint on it. One mechanic suggested I call it Mary Pickford, but that didn't appeal to me. After my first flight they agreed that if it was to be named after a moving picture star, Charlie Chaplin would be more appropriate.

September 4, 1918

Yesterday afternoon I took a hike up toward the trenches with a couple of the fellows here. In crossing a field I found a Hun incendiary bomb sticking in the ground. The safety pin had not been pulled out as it left the plane and it had



not exploded. We took it apart to find out how it was made. The main body of the bomb was filled with gasoline and some other inflammable material soaked up on cotton. I unscrewed the nose, which is the business end, and carried it home with me. Last night I took it apart, but I haven't discovered yet just how to get the explosive cap out without getting blown up. If I can get the cap out I will send the rest of it home as a souvenir.

October 7, 1918

I always knew that Americans were great souvenir hunters but never before did I realize just how far they would go in their hunt and what a queer lot of articles they classified as souvenirs. My poor Spad that I was forced to leave up near the front lines was a sorry sight when I visited it yesterday to remove the instruments, guns, etc. The guard that I had so thoughtfully secured was gone, and so was almost everything else. The clock, the compass, the thermometer,

"My two mechanics are as proud of that plane as I am," Plush writes of his Spad XIII (right). "I am afraid they are going to keep it too bright and shiny and it will sparkle too much in the air."

Squadron mascot Spad, who survived a mustard gas attack in the war, poses with a Spad bearing the 49th Aero Squadron insignia (below).



I hated to leave the Spad up there, for it was like deserting an old friend, but we could do nothing else. It would be impossible to take it out of the mess of wire entanglements, shell holes, and trenches without taking it completely apart and carrying it out by hand. Being under almost constant shell fire from the German light guns, about the only thing that could be done was to remove what we could and leave it to its fate.

I cut the insignia, a wolf's head, from the fuselage and will send it to you by mail. It is the insignia of our squadron and is painted on all our planes. The hole you will see in the head was caused by a Hun bullet.

October 15, 1918

Did you get the wolf's head I sent? Before mailing it I forgot to paint the iron cross in the wolf's mouth. You see, whenever we get official credit for a plane it is the custom to paint a small iron cross on the insignia. You can put one in if you care to, for I brought down a German plane in that fight in which my machine was disabled. I may get credit for assisting in the destruction of another but I am not sure about that yet. The cross is about an inch square and is put in something like this.



the spark plugs, the starting magneto, were gone. The guns were there but the locks were missing. Even the small windshield was gone, and the brass cap of the oil tank was probably an added weight to some heavy pack.

We took off what was left of any value and left the plane to take care of itself among the frequent rain of shells that drop regularly in that vicinity.

November 10, 1918

Just this minute we received word that the Kaiser has abdicated. I suppose this means the beginning of the end.

I have been on flying duty now for over 10 weeks without a day off, so I am rather anxious to get a few days. I smashed my plane yesterday and am now waiting for a new one. Just as I was leaving for a patrol, a connecting rod broke and smashed up the motor. I was at 2,000 meters altitude and thought I could make the field safely. I misjudged the field by about 50 feet and hit a lot of bushes. Besides pushing my face through the windshield, smashing the landing gear flat, breaking a wing, and turning the plane up on its nose, nothing else happened. The plane suffered worse than

I did. I



pushed my nose in a little and cut myself a trifle below the left eye, but that was all. I was in flying commission the next day, but the plane will have to go to a hospital.

November 22, 1918

The latest rumor has it that this group will sail for home soon so as to be in New York for the Christmas parade.

Will write again soon. I ate too much dinner for such strenuous work as letter writing.

P.S. You can put two crosses on that wolf's head now, as I received official credit for two enemy planes.

On November 25, 1918, Plush was awarded the Distinguished Service Cross "for extraordinary heroism in action near Romagne, France, 4 October 1918," according to the citation. "Lieutenant Plush was a member of a patrol of



seven machines which attacked seventeen enemy Fokkers. After shooting down one of the enemy, this officer returned to the fight and shot down another." The battle turned out to be one of the biggest bombing fights in history. In the dogfight in which Plush won the DSC, the Spads of the 2nd Pursuit Group shot down 11 Fokkers; the 49th Squadron got credit for seven.

Sightseeing in a city under siege (left) and a ravaged countryside (above).

Aboard the S.S. Regina February 3, 1919

Now that it is all over, what is there to look back upon? The fifteen months in France have been like a book with strange chapters, a book that one reads and casts aside as impossible, but a book that leaves a lasting grip on the imagination.

I used to watch the small planes as they manoeuvred in the air and felt that I presumed too much when I hoped to fly one myself. Flying became a reality when I learned to fly a clumsy and safe Caudron. After that came the Nieuport school with its three types of training planes, the 23-meter double control, the 18-meter solo, and finally the 15-meter scout plane. And then the work in acrobatics, formation flying, combat practice, and a month's course in aerial gunnery.

"Training completed and ready for active duty at

will be there soon after that because we expect to turn in our planes in a few days.



run into woods and out as the whole region is spotted with bursting shells. A tank is on its side here, a shattered truck there, horses running madly in their blind flight. The enemy are in absolute confusion by the rapid advance of our own troops. The fury of the storm did not last long but the story of the St.-

Mihiel offensive will never be erased.
(Nearly 1,500 Allied aircraft participated in the five-day St. Mihiel offensive, the largest concentration of air power in the history of the war.)

the front" sounded like a voice in a dream. A few days later I was at the front.

I fly again my first flight over the lines when everything was new, mysterious, and awful. The imprint of that picture will never fade, and I will always see a picture, not of war and destruction but of beauty and peace. There below, far below, is picture after picture slowly passing by, set in thick frames of clouds, colors, and shadows, and white dazzling light. There on my right is Metz, and off to the left lays Nancy, like a jewel set in dark green. One is a German city, the other French. Can it be that the men who inhabit each are bitter enemies and fight to kill?

I was soon to discover that this peace was only the calm before the storm. And when the storm did break in sudden fury on the morning of Sept. 12, I saw my picture of peace shattered and torn.

I live again that eventful day. It is before dawn and the guns pound and hammer the enemy. The whole skyline of the north is luminated by continuous flashes. Now it is dawn and we leave the ground to play our small part in a mighty struggle. Low clouds and a light rain forces low flying, so from our altitude we see a great army in action.

I see again great tanks waddling and lumbering their way toward Montsec with khaki-clad troops hanging thick on their backs and following in the rear. The roads are jammed with troops, pursuer and pursued. Scattered troops

I see and live again the long weeks of struggle in the Argonne region, where dodging "archies" [anti-aircraft fire] became a routine duty, bombing raids a daily occurrence, and strafing enemy troops a dangerous but ordinary work.

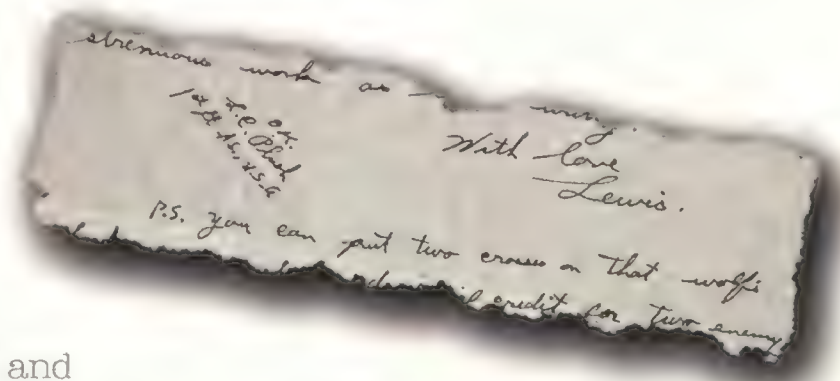
I can hear the machine guns rattling from the ground as they desperately try to rake us from the air as we swoop down and pour deadly streams of lead into masses of troops. A single bullet in the motor, a pierced gas tank and a burst of flame, a broken wire or a broken feed line and the game is over—lost.

I can hear the archies as they burst uncomfortably close. I can feel the plane as a bursting shell upsets it and starts it spinning, but a quick movement of the controls rights it and on I fly. A burst of black smoke on my right, flying splinters, crumpled wings. The archies have scored another victory—another dear friend gone west.

Over and over I live a terrible moment. Glancing quickly behind I see the sinister silhouette of two Hun planes diving directly at me from above. I am alone and



A Nieuport 24 surrenders (top, left); Show Me the Way To Go Home (above).



escape seems impossible. One is now almost on top of me and as I make a quick turn he fires at close range. I see again the streaks of fire. Phosphorus fumes of the incendiary bullets fill the cockpit full of that sickening odor and with a damaged motor I fight the fight over again for my life.

I fly again with great formations of bombers in their daylight raids and take my place above with the other scout planes as we sweep the sky for the enemy. The enemy appears and puts up a stubborn fight. One, two, perhaps more, flaming planes crash to the ground, friend and foe, and the bombers return, their mission accomplished.

"One of our planes did not return," says the official report of the day and we each wonder but dare not ask aloud, "Who will be next?"

Oh, fateful vision that now appears of three comrades, three friends that shared the same billet in the home of a French family near the flying field where we worked and played together. I am one of the three. The other two are dead.

How can I ever forget that evening as we sat before the open fireplace. I was writing a letter with a single candle as light. Roth, you were reading aloud from a book of poems, and your sudden burst of enthusiasm would make the flames



A quiet corner of the French countryside (above); members of the 49th Aero Squadron and mascot Spad (below).

leap.

Kinney, you were making and remaking the fire, playing with the embers with the fire tongs and returning the jumping sparks to their bed.


How little we knew what the morrow would bring. The next evening, Kinney, you and I sat by the fire alone. And a few evenings later, I alone sat by the fire and wondered. The story is always the same: a combat with the enemy and one of our planes did not return.

I walk again over a battle field fresh with its dead and ruin; shattered villages standing as monuments of destruction. Tangled and torn wire litter the barren fields and slopes, barren of life but littered with the waste of war—broken guns, bits of clothing, shells, and the sad remains of life.

There was a war, a great war, and now it is over. Men fought to kill, to maim, to destroy. Some return home, others remain behind forever on the fields of their greatest sacrifice. The rewards of the dead are the lasting honors of martyrs for humanity; the reward of the living is the peaceful conscience of one who plays the game of life and plays it square.

Lewis Clifford Plush was honorably discharged from service on February 15, 1919. He returned to his hometown, Pomona, California, and homesteaded property in the coastal mountains a hundred miles north of Los Angeles. He married in 1923, planted apples and raised turkeys on the ranch, and died in 1956 at age 63. His grandson Gary Lee, who provided the letters and photographs, today raises turkeys on the family ranch. —✈






First class, second row.

At this time we are boarding second-row passengers in the first-class comfort of the all-new Lincoln Navigator. Upon entry, notice the fine leather and rich wood accents located throughout the cabin, including the steering wheel and center console. In its class, only Navigator





offers exclusive second-row bucket seats with leather surfaces and a center storage console. For more information about this full-size luxury SUV, call us toll-free at 1 888 2ANYWHERE (1 888 226-9943), visit www.lincolnvehicles.com or see an authorized Lincoln Navigator dealer.

Navigator from Lincoln. What a luxury  **should be.**

COMMENTARY:

GPS, Inc.

The Global Positioning System is one of the great technological advances of the 20th century. Consisting of 24 satellites that orbit the earth at an altitude of 10,900 miles, plus five ground stations that monitor and correct the satellites' continuously transmitted signals, GPS offers precise position location services worldwide. Since becoming fully operational in 1995, it has become an increasingly indispensable element of many human endeavors. Its development by the U.S. Air Force is an unqualified blessing.

Its continued operation by the Air Force, however, may well be a curse. The potential of GPS for civilian uses is immense. But continued military ownership and control of GPS is frustrating these potential gains. The solution to this dilemma is to recognize GPS as an emerging international utility and transfer it to civilian control.

GPS was originally conceived three decades ago as a way to significantly improve the accuracy of weapons delivery and of positioning precision for all types of military units and vehicles, from infantry riflemen to strategic bombers. As the years rolled by, its creators decided to open up GPS access, not just to U.S. citizens but to the civil world—albeit at a substantially lower level of accuracy so as to maintain a military advantage.

GPS is now being put to uses never contemplated by its creators. Farmers are able to make more efficient use of fertilizers and herbicides; geologists, with a little patience, measure shifts in the earth's tectonic plates to an accuracy of a few millimeters; sailors can return to a precise spot in a trackless ocean to rescue a shipmate who fell overboard; automobile drivers may now

use displays in their cars to show not only all streets of interest but the shortest route to the nearest gas station, the next motel, or the cheapest pizza.

Indeed, more than 90 percent of GPS use is civilian. Yet Air Force management policies continue to favor military use. The worst abomination perpetrated by its managers is the intentional degradation of GPS known as selective availability, which increases the average error of the system: the military-use signal has an accuracy of about three meters, or 10 feet; the degraded signal is accurate to only about 100 meters.

Selective availability becomes truly preposterous when one considers

that several other government agencies—the U.S. Coast Guard, the Federal Aviation Administration, and the Federal Railroad Administration among them—are broadcasting or planning to broadcast signals to eliminate degradations in their locales. Consider also that the Russians' satellite navigation constellation—a virtual clone of GPS known as GLONASS, for Global Navigation Satellite System—features no deliberate degradation. Finally, there's the ready availability of portable commercial units that can continuously broadcast GPS signal corrections that reduce the positioning error to one meter or less. Yet current policy has selective availability remaining in effect for a minimum of three and a half more years and possibly as long as almost 10 years—despite an apparent lack of any true military advantage.

My real grievance with the system, however, is that there is no coherent plan to make it even better. A GPS under Air Force control is subject to the vagaries of Air Force budget priorities. Forced to compete with B-2s, F-22s, and C-17s, enhancements to GPS don't stand a chance.

What improvements are needed in a system that already seems to satisfy so many? Three—which commercial GPS management could commence immediately—come readily to mind.

First, the number of satellites in the system should be increased. Four satellites are needed to give a good position fix. Flying at fairly high altitude you may be able to "see" eight to 10 satellites at a given time; in a canyon you may be able to see only two



Albert W. Blackburn says it's time for the Global Positioning System to go civilian.

or three. The same problem arises in big cities: The buildings get in the way. A constellation of 48 satellites, rather than the current 24, would greatly increase the system's utility. The Federal Railroad Administration, for example, is concerned about its inability to offer adequate safety and tracking devices to trains traveling along deep canyons and steep mountains. Also, more satellites would mean a better position check and a system less sensitive to the failure of one of its satellites.

One way of achieving the above is to merge the U.S. GPS and Russian GLONASS. In addition to ending up with double the number of satellites, we could gain the advantage of the Russians' more reliable and cheaper satellite launch capabilities: They put up three at a time with a single booster. There would also be the advantage of having another master control station halfway around the world. Aside from offering a backup in the event of terrorist activity, earthquake, or some other catastrophe, a second master control station would enable correction signals to be broadcast twice as often.

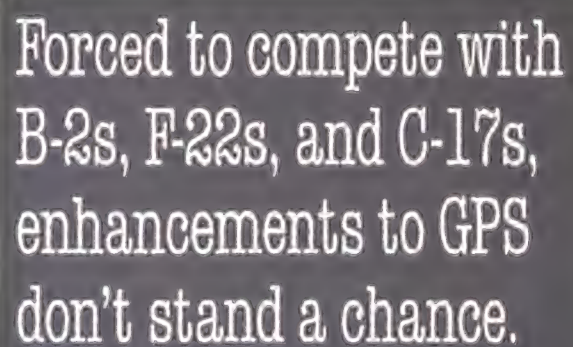
Third is the addition of a second civil frequency, which the civil user community has been pleading to have implemented for GPS broadcasts. Known as L5, it would greatly improve the accuracy and robustness of GPS signals, especially in periods of atmospheric disturbances. Solar flare activity, for example, can seriously degrade accuracy. L5 would detect and adjust for that.

If GPS were privatized, an independent revenue stream would become available for aggressive improvements to the system such as these, untainted by other priorities. With all users having a say in the nature of these improvements, there may be quibbles as to how much better and how quickly, but the demands for the improvements are going to be met far more expeditiously than can be expected

from a budget-strangled Air Force.

It's easy to envision the potential savings in lives that could result. In civil aviation, for example, my estimates indicate that about 1,000 lives are lost per year because pilots have inadequate positioning information.

But there's also a tremendous economic incentive to privatizing GPS. Thus far, GPS has been made available to the



Forced to compete with
B-2s, F-22s, and C-17s,
enhancements to GPS
don't stand a chance.

world free of charge—free to everyone, that is, but the U.S. taxpayer, who has borne 100 percent of GPS's costs. Already the Air Force has invested over \$8 billion in the GPS constellation and its ground support facilities. A contract of \$164 million was recently awarded for three additional satellites. Allowing for losses at launch—as happened this past January when a Delta II booster blew up moments after liftoff—this amount provides only about one year's replenishment to keep the system at full strength. The expense of launches, staffing, and a modest amount of research and development brings annual GPS operating costs to between \$400 and \$500 million.

To recover the large investment in GPS, I propose auctioning the system in a two-step process: The first step is to identify qualified operators for the system; the second would award ownership to the highest qualified bidder. The new owners would recover their investment, operating costs, and the cost of further embellishments by as-

sessing user fees on a national or regional level. For example, we know precisely how many revenue passenger miles commercial airlines fly throughout the world each year. If the international airlines pay 1/10 of a penny per revenue passenger mile, or roughly 1/15 of the current U.S. ticket tax, revenues from that source alone would be \$2 billion.

That is substantially more than the expenses needed to operate the system, which include amortizing the purchase price, increasing the size of the constellation, and investing \$250 million each year in research and development. As profits zoom, the vast number of users will force the fees down in a very short time.

These fees would be collected by the GPS operator based on an agreed-upon schedule. There would also be set fees for automobiles, ships, trains, surveyors, and so on. An adjustment based on gross national product per capita would help the poorer regions avail themselves of GPS at lower costs until the magic of the technology elevates them into higher levels of income.

It may take a decade to put it all in place, but the time to adopt the policy so it can all start happening is now.

More than five years ago, *Air & Space/Smithsonian* reported to its readers on GPS (June/July 1992). The article noted: "Already there's loose talk in the corridors of the Pentagon about the aggravation and expense of maintaining the system, and predictions that it will probably be turned over to civilian control one day." That was before GPS had become operational. With the costs getting ever greater and the Air Force budget tighter than anyone can remember, that day has come.

A former test pilot and FAA associate administrator, the author worked on navigation satellites in their conceptual stage for the defense department in the early 1960s.

The background of the image is a dramatic seascape. The sky is filled with dark, heavy, and swirling clouds, suggesting an approaching storm. The horizon line is visible in the upper third of the frame. Below the horizon, the sea is a deep, murky green color, with visible ripples and small waves. In the foreground, the water is more turbulent, with white foam and spray from a wave breaking, creating a yellowish-green hue. The overall mood is intense and powerful.

SURFING THE



SOLAR SYSTEM

It's wetter than you think.

by Michael Milstein

For the better part of 30 years, ice has fascinated Max Coon. He has spent month after month in the Arctic, inspecting fields of ice that look to the untrained eye like a flat and barren wasteland but to him are a restless world, alive with change and motion. Stocky, with a Kris Kringle beard and a deep but lively voice, Coon would look right at home at the North Pole. He has, in fact, worked near there, studying the structural behavior of ice for the Navy, NASA, and the National Science Foundation. Among scientists he is best known for his computer model explaining how plates of polar ice grind together to build ridges, as tall as a person, that

sometimes run for miles, the only topographic relief in sight.

Coon thought he had ice pretty much figured out until, about four years ago, he got a phone call. Do you think, asked the voice on the other end, that your model could work on another world?

The caller was Robert Pappalardo, then at Arizona State University and now a planetary geologist at Brown University. Pappalardo was intrigued by ice too, but his ice was about 500 million miles away from Coon's—on Europa, a moon circling Jupiter.

After studying photographs beamed back from the Voyager spacecraft that swept past Europa in 1979, Pappalardo

had puzzled over interlocking ridges crisscrossing an incredibly smooth surface of what he knew to be water ice. He and Coon recognized that the ridges on Europa looked a lot like the ones that creep, vein-like, across the ice off the North Slope of Alaska. In an unusual partnership of earthbound and planetary science that would later become the rule in the study of Europa, they reworked Coon's model to fit the moon. And what it told them seemed less important than what it did not.

"I can find nothing," Coon says, tapping a glossy photograph of the European ice in his Bellevue, Washington office, "that says this is not floating."



ALL PLANET PHOTOS: CEPS/NASM

Planet: Mars
Last visited: Mars Global Surveyor, 1997 (still in orbit)
Water prospects: Past rivers and floods, possibly large oceans. Today water is locked in polar caps and—perhaps—in groundwater, frozen lakes, and hydrothermal springs.

Earth's atmosphere at the rate of 20 a minute. Strange radar echoes from Mercury, the closest planet to the sun, suggest that permanently shaded craters near the planet's poles may protect ice deposits. Similar radar data have hinted at ice on the moon, although the finding is, as scientists like to say, controversial. Venus has virtually no water now. But the ratio of hydrogen to a heavy hydrogen isotope called deuterium in its atmosphere indicates that the planet probably had liquid water at

Floating.

On an ocean of water. Half a billion miles away.

The inviting blue mantle of water that nearly covers the Earth has always seemed our planet's most distinguishing characteristic. But as astronomers look closer at the rest of the solar system and beyond, they are arriving at the conclusion that Earth is really not that special after all. Water, one of the most abundant chemical compounds in the universe, turns up almost everywhere we've searched: on the moon, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto, on many moons of those planets, in comets and meteors, in the sun and perhaps on Mercury, all over interstellar space, and, most likely, on planets circling other stars.

Most of it is ice. But photographs of Europa taken by the Galileo spacecraft over the past two years show cracked ice plates that almost surely have slid apart, reaffirming what Coon and Pappalardo and others had begun to suspect—that the surface we see is probably no more than a frozen shell floating atop a massive global sea. Other moons, too, show external signs of liquid interiors. And Mars, which may once have had oceans as large as Earth's, likely still has pockets of groundwater beneath its arid surface.

The next step of logic cannot be far behind. Water is an essential ingredient for biology, the all-important solvent that breaks down organic molecules and allows them to interact with one another. On Earth, wherever liquid wa-



UPI/CORBIS/BETTMANN

ter exists, so does life. Does the same rule hold true elsewhere?

The connection between water and life explains much of our interest in finding water on other worlds, says John Rummel, former head of NASA's exobiology program and now director of research at the Marine Biological Laboratory in Woods Hole, Massachusetts. "We've always suspected there's lots of water around, but we haven't had the technology to confirm it," he says. "I think that's what's happening now."

The evidence has been turning up in unexpected places. Astrochemists studying the solar spectrum have found water in sunspots. The Earth-orbiting POLAR satellite recently lent support to a provocative 11-year-old theory that water-bearing comets are bombarding

one time, then lost it to a runaway greenhouse effect.

Then there's Mars, covered by channels and teardrop-shaped erosion scars that say—no, scream—water.

The Pathfinder spacecraft's spectacular basketball landing on Mars last summer brought it to a stop on a bone-dry flat, but its cameras revealed clear signs of a spectacular flood that raged across the surface more than a billion years earlier. Had you been standing on the 60-mile-wide Ares Vallis floodplain at the time, you would have seen a torrent hundreds of feet high racing toward you at breakneck speed. The deluge would have made the combined flow of the Mississippi, Amazon, and Nile rivers look like a trickle, and could have filled the Mediterranean Sea

overnight. Pathfinder's Sojourner rover trundled past unmistakable vestiges of this cataclysm: water-worn stones and rocks piled up like cars in a series of rear-end collisions.

Scientists have a hard time conjuring up a source for so much water. One remote possibility is volcanic activity, which might have rapidly melted Martian glaciers and triggered the flooding. Liquid water might also have pooled in aquifers beneath surface permafrost, only to be suddenly released when a tremor—a Marsquake—or cometary impact cracked the seal.

Figuring out where the water went is just as difficult. Some remained locked in the Red Planet's icy polar caps, some likely was lost to space, and a trace shows itself as frost on cold Martian mornings. But these fates can't account for the enormous volume of water that once so vigorously carved up the Martian crust, says Michael Carr of the U.S. Geological Survey in Menlo Park, California, leader of the team that interpreted images from the Viking missions of the 1970s. One possibility is that runoff from the floods filled large lakes that froze into permanent ice deposits still awaiting discovery. And some water may have soaked into the normally

frozen (and therefore impenetrable) ground during warm spells or in volcanically heated hot spots.

Mars Global Surveyor, a camera-equipped spacecraft that began circling Mars last September and will map nearly the entire surface before its mission ends in 2000, may be able to zero in on such reservoirs. But the only way to find them with certainty and figure out how deep they lie would be to drill beneath the surface, an intimidating challenge for spacecraft engineers. A robotic lander due to touch down on Mars in early 2000 will dig only a foot or two into the soil, looking for permafrost. Much deeper drilling may require heavier equipment—which may in turn require resident human supervisors.

There is also a chance that water may simply surface on its own.

"I wouldn't be surprised to be walking up a canyon on Mars and find a spring hissing off icy steam," says Norman Pace, an evo-

lutionary microbiologist at the University of California at Berkeley. And, he continues, wherever you discover water and heat coexisting with rocks containing hydrogen, it makes sense to search for life.

The possibility that Mars is still wet is exciting because of the planet's nearness and similarity to Earth. But most of the solar system's water resides in the frigid outposts beyond the asteroid belt. Shortly after the sun was born, when it was younger and more active,

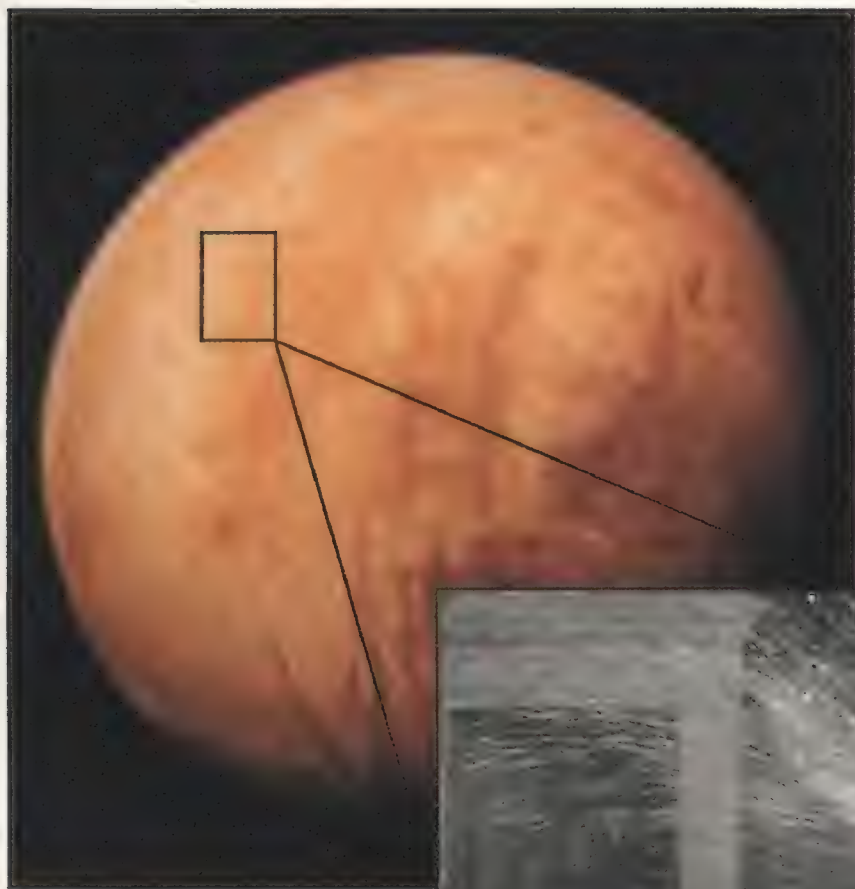


THE KOBAL COLLECTION



Moon: Saturn's Enceladus
Last visited: Voyager 2, 1981
Water prospects: Signs of past resurfacing by water. May still have water volcanoes.

it burned off most of the water and ice from the inner, rocky planets. By contrast, the gas giants of the outer solar system—Jupiter, Saturn, Uranus, and Neptune—are still loaded with the stuff, although under such astounding pressures and mixed with such a noxious stew of other compounds that it's a stretch to think of it as water. Two years ago a probe released from the Galileo spacecraft encountered virtually no water during its descent through Jupiter's atmosphere, but that turned out to be an illusion. By chance the probe had hit a dry spot, a kind of Jovian desert;



Moon: Jupiter's Europa
Last visited: Galileo, 1995 (still in orbit)
Water prospects: Ice "rafting" suggests an ocean under the moon's icy crust.

scientists are fairly certain that rain and snow are falling nonstop elsewhere inside the giant gaseous sphere.

However much water the outer planets may hold, only their moons are likely to have true extraterrestrial seas. First, though, there has to be a source of heat to turn all that ice into liquid. The sun is too far away to offer much in the way of warmth. Internal radioactive decay could contribute some heat, but occurs only in moons with rocky centers and can't account for much melting by itself.

The final option is tidal heating. Gravity, particularly the awesome gravity of a behemoth like Jupiter, exerts a strong tug on moons in elliptical orbits. As the satellite orbits closer to its parent, the

planet increases its pull. As the moon glides farther away, the paternal pull loosens. All the while the smaller body is squeezed and relaxed, squeezed and relaxed, like a rubber ball in your hand. And lo and behold, heat rises from its center.

The twin Voyager spacecraft proved that

of Io's formation and subsequent volcanic activity had likely baked it away.

The Voyager photographs of Europa were at a lower resolution than those of the rest of Jupiter's four large moons, but what the spacecraft did see was tantalizing. The pictures showed flat ice laced with ridges and crack-like lineaments, some longer than California's San Andreas Fault. The surface also appeared to have few craters, even though comets and asteroids should be battering the moon routinely as Jupiter's gravity sucks them in.

Here was a mystery: the case of the missing craters. Europa is about the size of Earth's moon, and astronomers believe it has a rocky core. Perhaps tidal heating stoked that core and softened the overlying ice so that craters flattened out like ice cream in the sun. Or, just maybe, Europa's core is an underwater Io, with volcanic heat maintaining a hidden, salty sea. According to this theory, the sea would occasionally flood the surface, filling divots before vaporizing into the wispy atmosphere or freezing solid to the surface, where daytime high temperatures hang around 230 degrees below zero. Such scenarios were unfamiliar to many astronomers, however. So some like Robert Pappalardo paired up with terrestrial ice and water experts like Max Coon, who now works for Northwest Research Associates, Inc.

When plates of Arctic ice crack and slide apart, ice begins to form atop the water between them.

When they jostle back together, they crush that median ice and build ridges that line the cracks. Coon folds his hands like a steeple to illustrate this ridge-building process. "You see a mountain growing in front of you: pieces of ice snapping and rolling down. It really is



UNDERWOOD PHOTO ARCHIVES, SAN FRANCISCO

one of Jupiter's moons, Io, not only experiences this tidal heating but is racked by it, with the internal turmoil venting itself through sulfurous volcanoes that dot the satellite's pizza-colored surface. This explains earlier observations showing Io to be devoid of water: The heat

Dowsing on Other Worlds

Clustered at the back of a meeting hall in San Juan Capistrano, California, and chewing on submarine sandwiches, a group of astronomers and oceanographers assembled last fall to plan a mission to Jupiter's moon Europa. In boldface type, on an overhead projector, a viewgraph proclaimed their prime objective: "Detect Ocean."

"NASA is very good at studying planets with the assumption that they are solid," observed University of Washington oceanographer John Delaney. "In this case, we're going to have to use some serious oceanography." In other words, astronomers and oceanographers will have to start talking to each other.

In fact, they've already begun. More than two miles beneath the ice of Antarctica lies a reservoir of water the size of Lake Ontario, which NASA intends to use as a natural laboratory for studying life in extreme environments and as a practice range for learning to explore an extraterrestrial sea. Once this reservoir—Lake Vostok—was a true lake teeming with life. But then global cooling capped it with thick ice, leaving it isolated for millions of years. If scientists can plumb the lake's depths and study whatever organisms might live there—while being extremely careful not to contaminate the water—they may be able to use similar techniques to explore Europa.

"There is a lot to learn from Vostok that we could apply in terms of technology and knowledge to the future exploration of Europa," says Frank Carsey, an oceanographer at the Jet Propulsion Laboratory who expects the lake to harbor an icebound "zoo of extraordinary scope."

NASA already plans to extend Galileo's study of Europa by two years, but that mission is unlikely to find definitive proof of an ocean by the time it ends in 1999. So an interdisciplinary panel has recommended that the agency follow up with another orbiter equipped with long-wavelength radar that can penetrate Europa's surface ice and a highly accurate laser altimeter that can measure tidal flexing of the moon. The most serious obstacle will be the intense radiation that strafes Jupiter's inner moons, which would kill a human in minutes and would most likely limit a spacecraft's life to a month or

two. Heavy lead shielding could extend the mission lifetime but would require a bigger and more expensive launcher. Some of the technologies required for a radar mission might get a trial run at Lake Vostok as soon as 2001.

Next in line would be a Europa lander. One imaginative plan would have a robotic submarine melt through the moon's surface ice and dive into its supposed ocean, sending its findings via a fiber optic cable to a surface lander that would then relay the data to Earth. But some on the interdisciplinary panel prefer what they say is a more practical option: a basic lander that could drop to the surface and quickly sample the outer ice, looking for chemical signatures of life before radiation fries its electronics.

Any such Europa-bound mission—and NASA has yet to approve one officially—will join a small fleet of spacecraft searching for water throughout the solar system in the coming decade. Cassini, a big-budget explorer launched last October, will visit Saturn and its icy moons in 2004 and perhaps turn up evidence of water or ice flows. In 1999, a Delta rocket will launch the Stardust mission, scheduled to snatch icy interstellar dust particles and samples from the comet Wild-2 before returning them to Earth in 2006. Closer to home, the Lunar Prospector, part of NASA's "faster, better, cheaper" Discovery program, will rendezvous with Earth's moon this winter to scrutinize its chemical makeup. Onboard will be a neutron spectrometer that can locate as little as a cup of water in a cubic yard of the lunar surface and determine with certainty whether the moon holds water ice, which could sustain future space explorers.

If humans eventually find their way out into the solar system, water will be gold. Broken down, it produces oxygen for astronauts to breathe and liquid hydrogen and oxygen, "the best rocket fuels you could have, bar none," says David Kaplan, the lead scientist for a test project that will use a spacecraft launched toward Mars in 2001 to produce propellant from Mars' carbon dioxide atmosphere. Water would be even better. "The best resource we could possibly have is water. If we knew water was there, we would shift everything to figuring out how to access it," he says. "It's just the answer we would hope for."

dynamic and exciting," he says.

Coon and Pappalardo think they can explain the ridges that rise some 300 yards above Europa's surface if plates of ice two to four miles thick are rumbling around, opening and closing, atop an ocean of water that other modelers figure could be more than 30 miles deep. Coon is careful to say that this is not the only explanation for the ridges. But it's a plausible one that, if correct, would mean Europa's surface is active enough to wipe impact craters off the map.

The case got stronger after the Galileo spacecraft began transmitting high-resolution images of Europa late last year. The pictures were dramatic. They showed closeups of huge rafts of ice that appear to have broken up and sloshed around like ice cubes in a glass of water. Perhaps the most striking thing about the photographs is that they seem so com-

mon, so familiar, that someone without the slightest bit of astronomical expertise can take one look at them and quickly conclude: Icebergs. Ocean.

"They're just blowing us away," says Paul Geissler, a planetary scientist at the University of Arizona's Lunar and Planetary Laboratory and a member of the Galileo imaging team charged with interpreting the spacecraft's pictures. Perhaps the only way Galileo could document a European ocean beyond a reasonable doubt would be to photograph ice floes that have actually moved since Galileo's last visit, or geysers of water jetting from the surface. Toward the end of its mission the spacecraft will angle its cameras in hopes of detecting any such geysers. "We're as enthusiastic about this as everyone else," Geissler says. "It's impossible to look at the images and not see an active world."

Rarely does an oceanographer show up at NASA's Jet Propulsion Laboratory in Pasadena, California, but at a press conference to unveil the new Galileo images, John Delaney of the University of Washington did. He and Coon stood alongside astronomers, ready to discuss the likelihood of a European sea. Tall and imposing, with an affinity for poetry, Delaney can recite "The Cremation of Sam McGee" from memory—and did, in fact, at a conference in San Juan Capistrano, California, last fall that brought astronomers and oceanographers together to talk about Europa.

Only a year before, Delaney had invited Steven Squyres, a Cornell University astronomer who in 1983 had published a paper predicting liquid water on Europa, on an ocean cruise to see what might lie underneath all that

European ice. As Squyres descended nearly a mile and a half in the deep-diving submarine Alvin off the Pacific Northwest coast, he watched sunlight disappear far above, just as light would vanish beneath Europa's frozen shell. Soon he was in another world. Superheated clouds of water blackened by dissolved minerals billowed out of chimneys covered with clumps of bacteria, tube worms,

more oceans may be waiting to be discovered. A staff scientist at the Lunar and Planetary Institute in Houston, she has designed models showing that the orbits of Europa and Jupiter's largest satellite, Ganymede—which



Moon: Earth's moon

Last visited: Clementine, 1994

Water prospects: Ambiguous evidence of ice in craters at lunar poles. Lunar Prospector should settle the controversy early next year.



THE KOBAL COLLECTION

crabs, and fish—all parts of a food chain sustained not by sunlight but by energy from Earth's hot interior.

"It's a fantastic environment so different than what you are used to that it's hard to get your bearings," Squyres recalls. An expert on Mars as well as Europa, he bears a slight resemblance to a youthful Carl Sagan. Astronomers hardly ever get to visit the places they study, but the dive into the Pacific introduced Squyres to the practicalities of research in a liquid realm. "It gives you a real appreciation for the power and the complexity of the environment and of life that manages to find a place there," he says.

If Renu Malhotra is correct, even

also shows cracks and ridges on its surface—may have changed over time. By tracing their orbital dance backward, Malhotra has found that the orbits of both moons may have been more elliptical in the past and that tidal heating would have been 10 to 1,000 times more powerful than it is now. The key question, she says, is whether the frigid moons stored the heat like giant Thermos bottles or allowed it to radiate off into space.

"If they could store it, then Europa and Ganymede may still be huge heat sinks, and it's possible that Europa is still molten inside," she says. "Otherwise, there may have been a heat pulse over a relatively short period that was

responsible for the surface features. We tend to think the way it is now is the steady state—the way it always will be. But that's not necessarily so."

Based on her models, Malhotra wonders if orbital dynamics partially melted other icy moons as well. Miranda, for instance, revolves around Uranus in a tilted orbit, evidence of a past orbital idiosyncrasy that would also have warmed its insides. Indeed, Miranda displays terraced layers of old and new ice. Its neighbor Ariel has surface cracks and few big craters, suggesting a history of soft ice or water. Other scientists have speculated that Rhea, a moon of Saturn, is porous because volcanoes have spewed loose ice over its surface. And Enceladus, one of the innermost moons of Saturn, has plains undoubtedly resurfaced by water or ice, along with sinuous mountain ranges.

"I would say there's even more evidence of water on Enceladus than on Europa," says Squyres, who took on the role of spoilsport when he suggested early this year that Europa may have lost its heat through runaway convection and so may not have an ocean after all. He is not on the Galileo imaging team, but, pushed for an opinion of the newest Europa images, he says,

"There's lots of excitement. Everybody wants there to be water there. I recommend a cautious, prudent approach."

Recently the Hubble Space Telescope found that the orbit of Pluto's icy moon, Charon, is slightly more elliptical than expected, probably because both bodies revolve around the sun at an angle. That opens the door to tidal heating. And even though our only views of Charon are hazy, its surface appears active. "Something," says Douglas Lin of the University of California at Santa Cruz, "maybe even geysers, is bringing new material to the surface."

But before we send rowboats to Pluto, a word of caution: What passes for liquid on these frigid moons would not

was using to stir it," he recalls. The stuff out there on Charon could flow more like a glacier than a river.

So, says Kargel, "In terms of something that comes close to resembling our ocean on Earth, Europa is the best chance that we have." This particular point is expanding the ranks of what the late U.S. Geological Survey astronomer Eugene Shoemaker cheerfully called the "Europa Mafia," a class of researchers who believe Europa is more likely than Mars to hold signs of primitive life.

Would life necessarily require oceans like our own? The short answer is: We don't know. Ammonia mixtures are quite caustic, which makes them more

effective as household cleaners than as abodes for life. But microbes have been found in some very inhospitable places, from boiling, acidic hot springs to polar ice to pores within rocks miles below Earth's surface. Researchers funded by NASA and the National Science Foundation have just begun a concerted effort to assay such life, which may

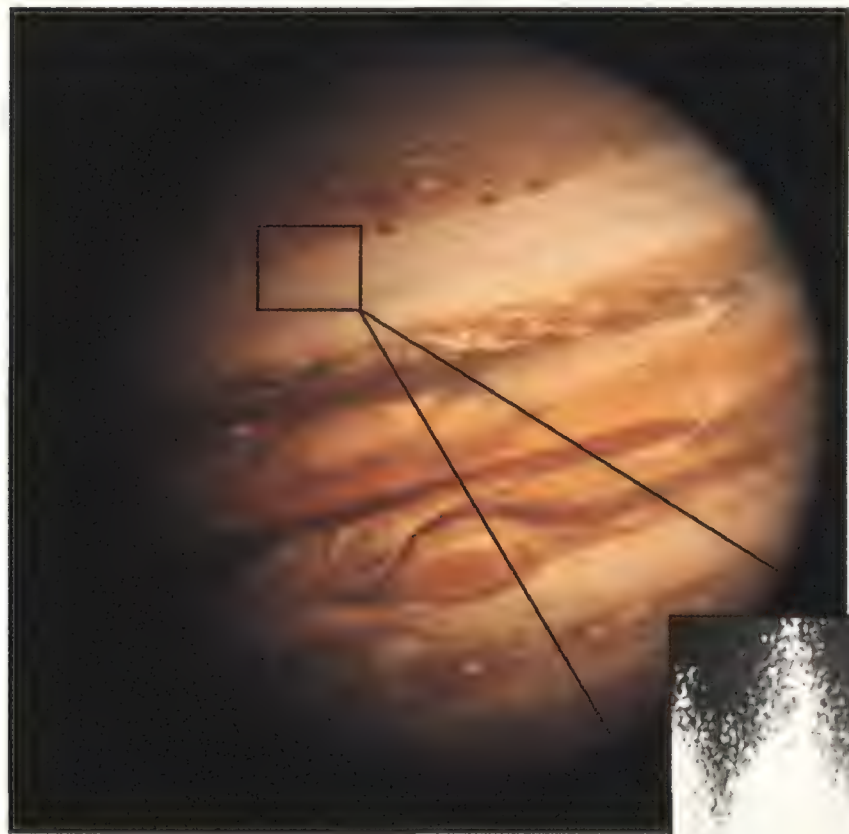
serve as good models of extraterrestrial ecosystems. Carl Sagan imagined gaseous jellyfish floating through the rainstorms of Jupiter's atmosphere. Right now scientists don't have enough information to assess whether that idea is ridiculous.

What might make planets havens for life, argues University of Colorado astronomer David Grinspoon, is not carbon and water but lively geologies and atmospheres that set up ever-changing palettes of creation. Grinspoon has spent 10 years studying the volcanic terrain and sulfuric acid clouds of bone-dry Venus, where, he muses, lichen-like creatures may gobble rich Venusian gases. Nature has crafted such a marvelous diversity of life on Earth, he says, that it seems almost an insult to impose too many limits on what it might come up with on other worlds.

"It's hard to know where to go with that idea," says Christopher Chyba, a University of Arizona planetary scientist and a leader in the emerging field of astrobiology. "Once you start wondering about such things, you drive yourself wild."

Sure, you could dream up a creature that doesn't require water to live. But why bother, when there's water everywhere we look? ➔

CORBIS-BETTMANN



Planet: Jupiter

Last visited: Galileo, 1995 (still in orbit)

Water prospects: Rain and snow believed to be falling throughout the atmosphere.

come out of your tap. To flow at all, water would have to be mixed with some kind of potent antifreeze like ammonia or methanol. Jeffrey Kargel, a planetary geologist with the U.S. Geological Survey, used liquid nitrogen to cool a vat of ammonia-water-methanol stew to just 10 degrees above its melting point. "It was so viscous I could barely, with all my might, pull out the railroad tie I



SECRET MISSION TO TIBET

The CIA's most
demanding, most
successful airlift.

by William M. Leary

Illustrations by Ken Dallison

Beneath the Lockheed C-130, few lights shone from the mountainous Tibetan province of Kham. But above the airplane, the lighting was spectacular. A full moon illuminated the Himalayas and gave a ghostly sheen to the American cargo plane, which had been stripped of all markings. As the Hercules began to descend, its crew scanned the ground for a T-shaped fire. Once they spotted it, the pilot lined the aircraft up to release its cargo: more than 20,000 pounds of arms, munitions, and supplies—and about a dozen Tibetan commandos, trained by the Central Intelligence Agency for a mission most of them would not survive.

Five minutes before the drop, pilot A.L. Judkins turned on a red light in the cargo compartment and depressurized the aircraft, the signal for the PDOs—parachute dispatch officers—to begin using their walk-around oxygen bottles and lower the cargo ramp in the rear of the airplane. Over the drop zone, Judkins turned on a green light, rang a bell, and pulled the nose up. The

PDOs cut the webbing holding the cargo on board, and the mass of weaponry rushed out the rear—as former PDO Miles Johnson puts it—“like a roaring freight train.” The Tibetans followed the cargo out the door and into the night. The entire process took only a few seconds, and then Judkins turned the aircraft south toward Thailand.

Between 1957 and 1960, the CIA conducted approximately 40 such drops over Tibet in a secret effort code-named STBARNUM to assist local forces in their struggle against Chinese occupation. (“ST” was the agency’s identifier for Tibet; BARNUM designated the weapons and personnel delivery arm of the overall U.S. program of clandestine assistance to Tibet, STCIRCUS.)

Although the Americans faced fewer dangers than their Tibetan counterparts—they would not set foot in the country or participate in fighting—the challenges they faced were enormous. The Tibetan airlift was the most operationally demanding mission ever undertaken by the experienced pilots of the CIA’s secret air force. “Penetrating a denied area is never easy,” says James N. Glerum, who served undercover with the CIA’s Far Eastern air operations during this period and later became head of the agency’s Special Operations Group. “But in this case, the ranges, the altitude, the lack of navigational aids for much of the mission made it to me a very challenging operation.”

The rapidly growing but ill-equipped resistance forces in Tibet welcomed U.S. assistance. Following the defeat of Chiang Kai-shek’s Nationalist forces on mainland China in 1949, Chinese Communist Party Chairman Mao Zedong had sent the People’s Liberation Army into Tibet to establish Beijing’s sovereignty over the remote mountain





land. In August 1950, Chinese troops quickly overran Tibet's tiny army and Mao imposed heavy-handed rule over the country, forcing collectivization of farms and attacking the deeply rooted Buddhist religious tradition of the people. Recognizing his country's weakness, the Dalai Lama, Tibet's spiritual and political leader, sought to avoid confrontation with the Chinese. But Chinese brutality soon sparked a resistance movement. As fighting escalated in the mid-1950s, resistance leaders in contact with the CIA—among them, the Dalai Lama's eldest brother—requested the help of the U.S. government.

To the Eisenhower administration, China appeared bent on aggression, both in Tibet and against the U.S.-supported Nationalist regime on Taiwan. Administration officials deemed assisting China's enemies to be in the best interests of the United States. While not prepared to assist the Tibetans openly, which could provoke a major confrontation with Beijing, President Eisenhower approved the provision of covert aid. As a result, the CIA was charged with exploring the feasibility of using clandestine air drops to deliver supplies to guerrilla units in Tibet.

The CIA had reason for confidence. It secretly owned an airline in the Far East, Civil Air Transport, which had a cadre of experienced personnel for the assignment. Later and more famously known as Air America, CAT had been originally formed by General Claire

Chennault of Flying Tigers fame after World War II as a cargo carrier based in China. But the airline had gone broke and was about to go out of business when in 1950 the CIA purchased it and its fleet of 20 or so airplanes—mostly C-46s and some C-47s. In the years that immediately followed, CAT aircraft had flown numerous covert air drop missions over mainland China. In 1954 CAT pilots had also flown through the flak-filled skies over the Indochinese village of Dien Bien Phu to support the doomed French garrison in its defense against the Vietminh. All the while, CAT continued to serve as the flag carrier for Nationalist China (Taiwan). While missions to Tibet would make heavy demands on the CIA's air crews, officials in the agency's air branch in Washington believed that their airline was up to the job.

In the fall of 1957, the pilot project got under way with the air drops into Tibet of two teams of Tibetan guerrillas selected by resistance leaders to act as the United States' liaison with the movement. The men, six in all, had undergone four and a half months of intensive training at a secret CIA base on Saipan. They had learned how to operate a hand-cranked RS 1 radio, how to use Morse code, and how to encode and decode messages using a system of numbers that represented letters. They had fired a variety of weapons—pistols, rifles, 60-mm mortars, and 57-mm recoil-less rifles. They had studied

with demolition experts and could set ambushes and blow up bridges. They knew how to identify and prepare terrain for air drops.

At the end of their training on Saipan, the first team, two Tibetans named Athar and Lhotse—known to the Americans as Tom and Lou—went to Okinawa to prepare to return to their country. Roger McCarthy, the CIA agent who ran STCIRCUS and trained the first six Tibetans, remembers them with fondness: Lhotse was "the big fellow," he says, "extremely friendly, warm, and incredibly strong." Athar was "built more like a fireplug, but extremely strong." McCarthy adds: "It was easy for all of us to look at them, to treat them, to think of them as brothers."

At Okinawa, CIA personnel modified standard T-10 parachutes with slots and tails to improve their rate of descent and steerability. Outfitted in padded jumpsuits and helmets with face protectors, Athar and Lhotse made three practice jumps from the aircraft they would use on their mission, a B-17 that the U.S. Air Force had turned over to CAT in 1952 for use in its missions into China.

Finally the Tibetans were flown to the staging base—an emergency Strategic Air Command recovery field at Kermitola, just outside Dacca in East Pakistan (now Bangladesh)—and in October 1957, they boarded the B-17 for the flight north. The unmarked aircraft was flown by Polish and Czech expatriates whom the CIA had trained in Germany for deep-penetration missions into Eastern Europe. If the aircraft and crew were lost during the mission, the U.S. government would deny all knowledge of them.

As the bomber climbed over the high mountains that marked the border of the Tibetans' homeland, a full moon illuminated the snow-covered mountain peaks and passes that Athar and Lhotse had crossed on foot more than six months ago. That journey had taken several arduous days; now they would cover the same ground in hours.

A full moon, or something close to one, was a necessary accompaniment to the flight. Because of a lack of ground-based navigational aids over most of the route, moonlight became

an important aid, and missions were flown only during the five days preceding and following a full moon.

Without exception, those involved in STBARNUM cite navigation as the fiercest test of the operation. "The major challenges were, first and foremost, equipment. We had none," says Lawrence Ropka, an Air Force navigator detailed to the project as a flight planner. "The airplanes did have a crude radar but there were no other means of navigation other than celestial and dead reckoning [which relies on the use of a compass and clock] and, of course, eyeball navigation: looking out the window and trying to determine your position relative to various terrain features. There were no radio beacons. There was nothing."

Ropka also cites difficulties created by the old World Aeronautical Charts the crews were using. "Many of them had white splotches in them, rather than colors, and that denoted that there was no accurate data available," he says. "As you would marry one chart with another, as was the custom at that time...it was always intriguing because the mountain ridges and rivers on one chart wouldn't match the mountain ridges and rivers on another, which"—Ropka laughs—"didn't in-

still a lot of confidence in the charts."

As the B-17 approached the Brahmaputra River, south of the Tibetan capital of Lhasa, the two Tibetans inside prepared to jump. The team's radio and other gear were tied to a 300-foot line; the line, in turn, was secured to the first jumper's waist. When the aircraft descended to about 1,000 feet above ground level, the cargo would exit the airplane first. The jumper could then follow the line to the cargo after landing. Upon a signal from the cockpit, a PDO tossed out the cargo. Athar followed, then Lhotse. Both men reached their intended goal: a large sandbar beside the river. After locating their gear and hiding it for later recovery, they bought a horse, made the 60-mile trek to Lhasa, and established contact with the resistance leaders.

A second team of Tibetans was scheduled to be inserted the next night, this time in the province of Kham, in the eastern part of Tibet. Heavy cloud cover, however, delayed the flight until the next full-moon period, in November. This mission nearly ended in disaster. As planned, the three-man team landed near a resistance force. But without prior contact, the guerrillas misidentified the jumpers as Chinese paratroopers. A brief firefight broke out. Fortunately,

ly, the jumpers were able to clear up the confusion before anyone was hit.

Once established, the two teams regularly communicated via radio with their CIA contacts in an agency facility outside Tibet, providing information on the resistance groups and Chinese forces in their regions. Before long, each was also requesting that arms and other material be air-dropped to resistance groups and providing information on possible drop zones. In 1958 the Eisenhower administration decided to grant continuing support to the resistance, including supply drops and the training of additional guerrillas.

Because the C-46s and C-47s in the CAT inventory did not have the range to meet the demands of this mission—which would require flights of several thousand miles—the CIA turned to the 322nd Troop Carrier Squadron on Okinawa. An Air Force special mission unit, it had a C-118—the military version of the DC-6—that handled sensitive operations for the intelligence agency. The Air Force agreed to provide it for the air drops, while CAT supplied the pilots, navigators, and radio operators.

To enlist PDOs for handling the cargo, the CIA recruited smoke jumpers through a connection with the U.S. For-



est Service. The key link was a former smoke jumper, Gar Thorsrud, who had been recruited by the agency in the early 1950s for missions into northwestern China and had gone on to a senior position in the air branch. He recruited other smoke jumpers—originally for their skill at jumping into small places with steerable parachutes—and a pipeline opened up. “I stayed with the forest service in the summertime and fought fires,” says smoke jumper and PDO Andy Andersen, “and then most of this stuff [in Tibet] was done in the wintertime. So when fire season was over, I’d just go back to Tibet.” PDO Miles Johnson knew 12 fellow smoke jumpers who joined the Tibet project: six from McCall, Idaho, and six from Missoula, Montana. “A lot of them went on to careers with the agency,” he says.

Mission planning began when a team on the ground radioed a request for an air drop, providing the locations for a primary drop zone and an alternate. Using photographs obtained by U-2 spyplanes, specialists in the air branch of the CIA’s Far Eastern division plotted a route into and out of the drop zone from mission staging sites outside Tibet. At the same time, they assessed the threat of enemy air action against the flights, determined payload, factored in weather, and made other judgments. The chief of the air branch then took the plan to Richard Helms, the number-two man in the CIA’s operations division (then known as the directorate of plans) for his consideration. When Helms—later director of the CIA during the Johnson and Nixon administrations—agreed to the mission, the plan went to Lieutenant General Charles P. Cabell, deputy director of the CIA, for final approval.

Lawrence Ropka was a navigator with the 322nd Squadron on Okinawa when he was assigned the task of final planning for the missions. He first confirmed the drop zones selected by the teams in Tibet, then worked the route backward from the drop zones, using the old aeronautical charts. Given the range limitation of the C-118, which was on the order of 3,000 miles, the aircraft would have to stop at Kermitola for refueling.

The CAT crews disliked the C-118,

a feeling shared by all those connected with the flight program. “For one thing,” says CAT navigator Jim Keck, “it didn’t have the power.” With four 2,500-horsepower Pratt & Whitney R-2800-52W engines, the C-118 had limited altitude capability, forcing pilots to weave their way through the high Himalayas, rather than fly over them. Also, says Keck, “it had a radar set that was mainly for weather avoidance; it wasn’t a navigator’s radar. The antenna wasn’t stabilized so when you went into a turn, you lost all your picture. So a lot of times in the [C-118] I’d tell them: ‘You have to roll out. I can’t see anything.’”

Because the C-118’s side door could not be opened in flight, it had been removed. Therefore the aircraft could not be pressurized, requiring the crew to remain on oxygen for much of the mission. And the airplane’s small door made it necessary to fly several passes over the drop zone to unload the cargo. As CAT pilots had learned from numerous air drop missions in China, Korea, and French Indochina, it was far better to unload the cargo in one pass lest unfriendly forces be waiting below. The C-118 would make a large, slow target for ground fire.

Ropka knew that the C-118 was operating at the limits of its performance. According to his calculations, however, the airplane should be able—barely—to return to Dacca if it lost an engine over Tibet. Late in 1958, a team of Air Force airlift experts showed up on Okinawa and ran tests on the C-118. Their calculations for three-engine performance knocked seven to eight percent off Ropka’s figures. “If this was correct, the airplane could never have gotten back on three engines,” he noted. Fortunately, the accuracy of the figures was never tested during a mission.

In 1959, STBARNUM entered a new phase. In May, two months after the Dalai Lama had fled Tibet with the assistance of one of the CIA-trained radio teams, the Eisenhower administration authorized a major expansion of the program. A total of 700 Tibetans were to be brought out of the country by land routes and then secretly flown in sequential groups to Camp Hale, a CIA training base near Leadville, Colorado. After three to four months of instruc-







tion in weapons, radio use, guerrilla tactics, and survival skills at the high-altitude facility, the Tibetans would be returned by air to organized resistance groups in the eastern and central parts of their country.

The first group reached Camp Hale early in August 1959, courtesy of the U.S. Air Force's Detachment 2, 1045th Operational Evaluation & Training Group. (Unlike the 322nd Squadron, which contained a small "cell" that worked for the CIA, Detachment 2 was made up entirely of Air Force personnel who had been detailed to the intelligence agency. As one CIA officer characterized the relationship, "We owned them.") Upon arrival, wrote John Avedon, who interviewed one of the trainees for his 1984 book *In Exile from the Land of Snows*, "the men were issued black combat boots and green army fatigues.

After breakfast, they were taken on a tour of the camp's immediate area, which consisted of ten buildings near the bank of a small river. All around, heavily forested mountains screened off the outside world, but even within the camp restrictions were imposed. Their barracks, the dining hall, the classrooms and a large room with odd-looking tables called 'pool' and 'Ping-Pong' were the only areas Tibetans were permitted in. They were told as much at their first lecture by a large instructor in combat fatigues. Informing the group that training would last for six months, the American concluded by asking two questions: 'Will you jump from an airplane? If so, raise your hands.' Pleased with the response, he smiled and said, 'Who wants to fight the Chinese?'

To carry the newly trained guerrillas to their homeland, the CIA readily

agreed to an offer from General Curtis LeMay, then Vice Chief of Staff of the U.S. Air Force, to use C-130As from the 315th Troop Carrier Wing at Naha Air Base in Okinawa. Compared to the C-118, the turboprop C-130s offered far superior safety and performance. They had roughly twice the horsepower and more wing area, which enabled them to operate at much higher altitudes. They were able to carry a heavier load and operate nonstop to Tibet from a secret CIA base at Takhli, Thailand, about 60 miles north of Bangkok.

The C-130 airlift began in July 1959 with cargo drops. The first group of Tibetans trained at Camp Hale was ready in November. During November and December, however, less than half of the nine to 12 flights scheduled for each full-moon period managed to complete their missions. The main problem came from the APN-59 radar sets on the C-130s. This equipment, necessary for en route navigation, had an excessive failure rate and caused numerous aborts. Also, the mission's heavy fuel requirement—40,000 pounds—meant that only 26,000 pounds of men and supplies could be carried, necessitating additional flights.

Unhappy with the airlift's slow progress, the CIA arranged for a new Air Force commander to take charge of the project. In January 1960, Major Harry C. Aderholt brought a new spirit to STBAR-UM. Associated with the CIA since the Korean war, "Heinie" Aderholt was a hard-charging leader who demanded results (see "Escape to U Taphao," Dec. 1996/Jan. 1997). One of his first targets was the radar sets. "The Air Force's APN-59 was all screwed up and shorted out every time we took off," he recalls. "I couldn't get the Air Force to fix it, so I got the CIA communicators, who were the best in the business, and they troubleshooted and found out that the problem was not in the components but behind the components—in the electrical system in the airplane."

Aderholt also took steps to increase the payloads for the C-130s. The maximum allowable gross takeoff weight of the aircraft was 124,000 pounds. The Emergency Wartime Planning maximum gross takeoff weight, however, was 135,000 pounds. Aderholt learned from Lockheed that the lower gross

weight was based on the side loads on the landing gear during taxiing, when any steering strained the gear to one side, and had nothing to do with engine-out performance. To solve the problem of side-load limitations, Aderholt says, "I had the C-130s lined up at the end of the runway at Takhli, then topped off with fuel." This allowed him to increase the takeoff weight to 135,000 pounds and carry 11,000 pounds of additional payload. Says navigator Jim Keck, Aderholt "really went to work for us, I think more than anybody else did."

Under Aderholt's leadership, the number of problem-free missions rose dramatically. A mission cycle began a minimum of three days prior to the beginning of the full-moon window. Air Force pilots from the 315th Troop Carrier Wing moved the C-130s from Naha to Kadena Air Base, where personnel from the aerial resupply section of the CIA's main logistics base in East Asia (code-named ZRBLUSH) would load cargo bound for Tibet. The cargo, mainly arms and ammunition, would be packaged into individual 80- to 85-pound loads that could be placed quickly on the backs of pack animals. Radio messages would alert the teams in Tibet to the drop, telling them how many bundles to expect and how many animals would be needed.

CAT pilots and crews then ferried the C-130s to Takhli, accompanied by the Air Force pilots, who checked out the CAT pilots' command of the aircraft. Upon arrival in Thailand, Aderholt's ground crews "sanitized" the airplanes, stripping them of their military markings. Twenty-four to 48 hours prior to a scheduled launch, Aderholt would receive an alert message from CIA air branch headquarters in Washington. If all went as planned, messages with the single word "Affirm" would come in 12 hours before the time of launch, then at six, two, and one hour before launch and finally at launch time.

The decision to launch depended primarily on weather conditions at the drop zone. In addition to the normal forecasting information from military and commercial sources, CIA air branch operations officers would receive weather reports from Tibetan radio operators, who had been supplied with cards that showed the types of clouds and cloud coverage. They would report this

information in simple Morse code. For example, if the mountain peaks near the drop zone were covered with clouds, the operators might send "XXX." If the clouds were scattered and moving rapidly across the mountaintops, they might send "RRR." If the sky was clear, they might use the code "CCC." Recalls CIA officer Roger McCarthy, "We soon found out that the weather reports from the teams were usually more accurate than those reported by all the 'modern' weather reporting services, including the military."

While the pilots, navigators, and radio operators were briefed on routes and weather, the PDOs examined the cargo and rigging and made sure that every PDO had at least three walk-around oxygen bottles (each held 30 minutes' worth of oxygen) for the depressurized portions of the flight. Shortly before the twilight departure, a contingent of Tibetans would arrive, normally 10 to 12 for each aircraft.

The aircraft scheduled for the night's mission, usually one to three C-130s, would take off from Takhli at 15-minute intervals. The first airplane—which would step-climb to an optimum altitude, sometimes as high as 35,000 feet, depending on the winds encountered—would cross over Burmese territory at dusk. After a few such flights, the Burmese government protested. The route was never significantly altered, however, taking the C-130s across Burma toward India. After crossing the

Brahmaputra River in Tibet, the crews navigated primarily by radar. As the aircraft crossed over the Himalayas, one navigator remained glued to his radar set while a second took star shots. The radio operator would send the Morse code signal "QQQ" to Takhli as the aircraft passed over designated checkpoints.

Many of the flights were long, taking from six to seven hours to reach the drop zone, but the scenery was spectacular. "All the flights were moonlit flights, and it was just crystal clear and it looked like in some cases you could just reach out and touch" the Himalayas, Miles Johnson says. Frequently the pilots would treat the PDOs to a geography lesson, pointing out Mount Everest, K-2, and other high peaks.

The airdrops were made at about 1,000 feet above the ground. "You could look out the rear as we made the drop and see all the little Tibetans running around and their pack horses and their little food fires, and all that kind of stuff," Johnson says.

The jumpers usually exited the aircraft without incident. One night, however, a problem arose. Unlike most missions, this one involved only a single Tibetan jumper. The drop zone was on a high plateau close to the Mongolian border. As the aircraft neared it, the Tibetan passenger, known to the Americans as "Dennis," was poised at the end of the ramp next to PDO Andy Andersen. Reaching the drop zone, the pilot



Yak butter tea break. The second and third from the right, were with the first group parachuted back into Tibet in 1957.

nosed up to deliver the load. At the last moment, however, the Tibetan hesitated, making an instinctive grab for Andersen. "We were standing there hugging each other," Andersen says, "and then I finally pushed him out, and somehow he got kind of tangled up. I had about a hundred feet of intercom cord on my harness with an alligator clip and he took the whole thing with him. He pulled it right out of the box where it goes into the airplane."

Andersen then tried to close the cargo ramp, using the automatic system, but it malfunctioned. The three PDOs had to crank the door shut with a manual hand pump. "This consequently used up more oxygen than normal and we were trying to monitor each other's oxygen in the meantime," Johnson recalls. "Andy [Andersen] was getting pretty weak so we got another bottle and plugged him in. By the time we got the static lines in and had hand-pumped the door closed, all the portable walk-around bottles had been used up."

Contrary to later rumors about Air America pilots receiving high pay, Aderholt has pointed out that the crews "actually lost money on the Tibetan program, as they could have made more on their regular flying schedule"—which they resumed between missions, flying passengers and cargo on the airline's commercial routes. Nonetheless, there was never a problem finding volunteers. Attracted by the prestige of the program, pilots used to compete to get into it, recalls Robert E. Rousselot, Air America's vice president for operations. In fact, they would become angry at him if not assigned to the airlift.

James Glerum, a CIA officer who served with CAT undercover as Rousselot's assistant, recalls that "Rouss had an almost uncanny ability to pick the right crews for these and other special missions." Also, Rousselot invariably put together crew combinations that worked well together. "I learned more about marrying people and special missions, and probably leadership in general, from Rouss than anybody I ever worked for or with," Glerum notes.

Aderholt recommended payment for the flights based on the level of difficulty. There were three categories: "A" flights received \$300; "B," \$500; and



"C," \$1,000. Most missions went without incident, and air crew members collected \$300. At least one mission, however, fell into the "C" category.

It began when two C-130s departed Takhli at twilight, separated by 15 minutes. In the cockpit of Able flight were M.D. "Doc" Johnson—pilot in command—and Jack Stiles, while on Baker flight was pilot in command William Welk and A.L. Judkins. Due to a rare navigational error (the navigators corrected for what turned out to be nonexistent jet stream winds), plus bad weather, both aircraft became lost. After a fruitless search for the drop zone, the two C-130s headed south.

With fuel running low, Baker flight decided to land at Kermitola, now used as an emergency field. "It was raining, there was a 30-knot crosswind, and the field had no runway lights," Judkins remembers. The only landing aid was a non-directional radio beacon. As he crossed over the beacon and descended toward what he hoped was the runway, a bolt of lightning suddenly illuminated the strip, and he was able to land without incident.

Meanwhile, Able flight had decided to try for Takhli. By the time the airplane reached the vicinity of the field, however, the fuel situation had become critical. A low-fuel warning light indicated that all tanks would be dry within minutes. Stiles was flying the airplane from the left seat. To his dismay, the area immediately around Takhli was obscured by fog. There would be time

for only one pass. If the aircraft could not land, the crew would have to bail out.

Aderholt and Ropka went to the end of the runway and began to shoot flares through the fog. Johnson, sitting in the right seat, spotted one of them just as two of the four engines died. But he now knew the location of the field. He told Stiles that he was taking over the controls, then put the airplane into a tight spiral to avoid the hills that were close to Takhli. Coming in to land, he spotted the field at 200 feet. He had just enough time to line up with the runway and set the C-130 down before the fuel ran out.

For Aderholt, this mission justified a payment of \$1,000. But when his recommendation reached Rousselot, it was turned down. Rousselot, Aderholt notes with some admiration, had high standards. He refused to approve any "C" payments, on the grounds that "it would spoil the pilots."

On May 1, 1960, the Soviets shot down Francis Gary Powers on a U-2 spy mission, causing President Eisenhower to suspend all clandestine overflights. Two or three additional missions would be flown in 1961 under the Kennedy administration, and the CIA continued to support the Tibetan program into the early 1970s—mostly through the supply of armament out of a CIA base located in the neighboring kingdom of Mustang, now part of Nepal. But STBARNUM ended effectively, if not formally, with the U-2 incident.

In 1959 and 1960, China poured in vast numbers of troops, heavy artillery, and vehicles, and the tide of battle turned against the resistance. Indications are that nine out of every 10 Tibetans who parachuted out of the C-130s eventually were captured and killed or committed suicide to avoid capture. A few months before the flights were suspended, Eisenhower, during a briefing by the CIA at the White House, expressed concern that their efforts might backfire. The president's special assistant for national security affairs, Gordon Gray, recorded the misgivings Eisenhower expressed in a February 1960 briefing. "The President wondered whether the net result of these operations would not be more brutal repressive

reprisals by the Chinese Communists who he felt might not find continued resistance tolerable," wrote Gray. "Mr. FitzGerald [Desmond FitzGerald, head of the CIA's Far Eastern division] pointed out that there could be no greater brutality than had been experienced in Tibet in the past." Documents captured from the Chinese later confirmed that in 1959 alone, the People's Liberation Army had killed 87,000 Tibetans.

Thomas G. Fosmire, a CIA paramilitary specialist who was involved in training the Tibetans, agreed with FitzGerald. The Chinese, he recently pointed out, were—and are—intent on controlling every aspect of Tibetan life and culture. The assistance provided by the CIA allowed at least some Tibetans—including the Dalai Lama, his family, and a number of high-ranking officials—to flee to India and Nepal. "No doubt, without our help, the destruction of Tibet by China would have been more complete," Fosmire contends.

In addition, Roger McCarthy has not-

ed, the CIA obtained valuable intelligence on the Cultural Revolution, Chinese military plans, and Communist Party directives, thanks to documents captured by Tibetan forces during ambushes of couriers and political functionaries. Furthermore, he says, "the Chinese timetable for Tibet was disrupted by years, not just weeks and months, because of the resistance efforts."

Last May, McCarthy returned to Tibet and met some of the surviving CIA-trained guerrillas, now mostly in their sixties. "To a man," he says, "they were ready to go again."

Between November 1959 and May 1960, some 35 to 40 missions delivered almost 400 tons of cargo to the resistance fighters of Tibet. James Glerum, former head of the CIA's Special Operations Group and familiar with the CIA's many aerial activities in the 1950s and 1960s, some of which remain classified to this day, calls STBARNUM

"the most professional of all Agency overflight programs." He terms it a complete success "in terms of the planning and the effectiveness against the operational parameters, which left little or no margin for error."

The director of CAT covert operations throughout Asia during the 1950s and early 1960s, Rousselot also praised the Tibetan airlift. "Excellent facilities, excellent equipment, and an excellent staging base," he pointed out, made STBARNUM "the centerpiece of agency air operations."

Lawrence Ropka says it's tough to find much of anything to compete with STBARNUM. "I, after 30 years in the Air Force and almost 40 in the government, find it hard to find a parallel when aviators start telling war stories—particularly fighter pilots," he says. "I sincerely wish that they could have seen and known that crowd, because they were just awesome men. They did this for nothing. And they did it magnificently." ➔



The North American Fish Spotter

Habitat: *Coastal skies in Alaska and New England.*

Distinguishing features: *Keen eyesight, preference for low altitudes, aggressiveness.*

Status: *Endangered.*

by Joseph Bourque

Dakers Gowans' Bellanca Scout is half hidden in the brush beside the gravel runway at Naknek, Alaska. He gives it a careful preflight, then we roll it out and taxi to the pumps. Brad Heil's PA-12 is there already, and I can see Mike Litzen's blue and white float-equipped Super Cub on the lake that parallels the runway. Two years ago, 60 airplanes would have been queuing up at Naknek, but today there are just these three. They are the last of the fish spotters working the Bristol Bay salmon fisheries.

Spotters fly above fishing grounds, usually between 500 and 800 feet, observing the movements of fish and communicating what they see to the boats whose captains have hired them. For the past two seasons the Alaska Board of Fisheries has imposed a ban on spotters in Bristol Bay. The Board, a group of seven citizens appointed by the governor of Alaska to rule on matters that affect sport, commercial, and subsistence fishing, decreed that pilots must cease spotting an hour before a fishing period opens and can't resume until an hour after the period closes. The restrictions severely limit the spotters' effectiveness and, consequently, their profit. Instead of 4 to 7 percent of a boat's gross, the Bristol Bay spotters now work for a flat or hourly rate.

We leave the ground about 10 a.m. There won't be any fishing at Naknek today, but an opening has been announced for 1 p.m. on the Egegik Riv-

er, about 40 miles south. We can fly there until noon. Although the Bristol Bay salmon season begins in the first week of June, its peak is right now, in early July. All of the salmon fishing occurs in the mouths of five rivers emptying into Bristol Bay, within boundaries set up by Alaska Department of Fish and Game biologists and defined by Loran navigation lines. Gowans has contracted with boats on three of the rivers—Naknek, Egegik, and Nushagak—14 boats altogether, most of them on the Egegik.

His airplane has the typical spotting equipment: tundra tires, of course, and several radios, including business band and marine VHF, all with scrambling devices. To help prevent mid-air collisions, Gowans has added a PulseLite system that alternately flashes two 50-watt halogen lights mounted on the landing struts. And he wears Polaroid sunglasses to cut the sun's reflection off the water.

There's no sun today. The overcast hovers at about 1,000 feet and it's raining. We settle in at 700 feet and head for Egegik. Gowans explains that he'll be looking for jumpers—salmon literally jumping out of the water, signaling a possible concentration of fish—on the way down the coast. Halfway there, Gowans reports to his boats that a large school is headed south. He teaches me how to spot the jumpers: bright flashes with a spume of water. An hour later, I'm still struggling to tell the jumpers

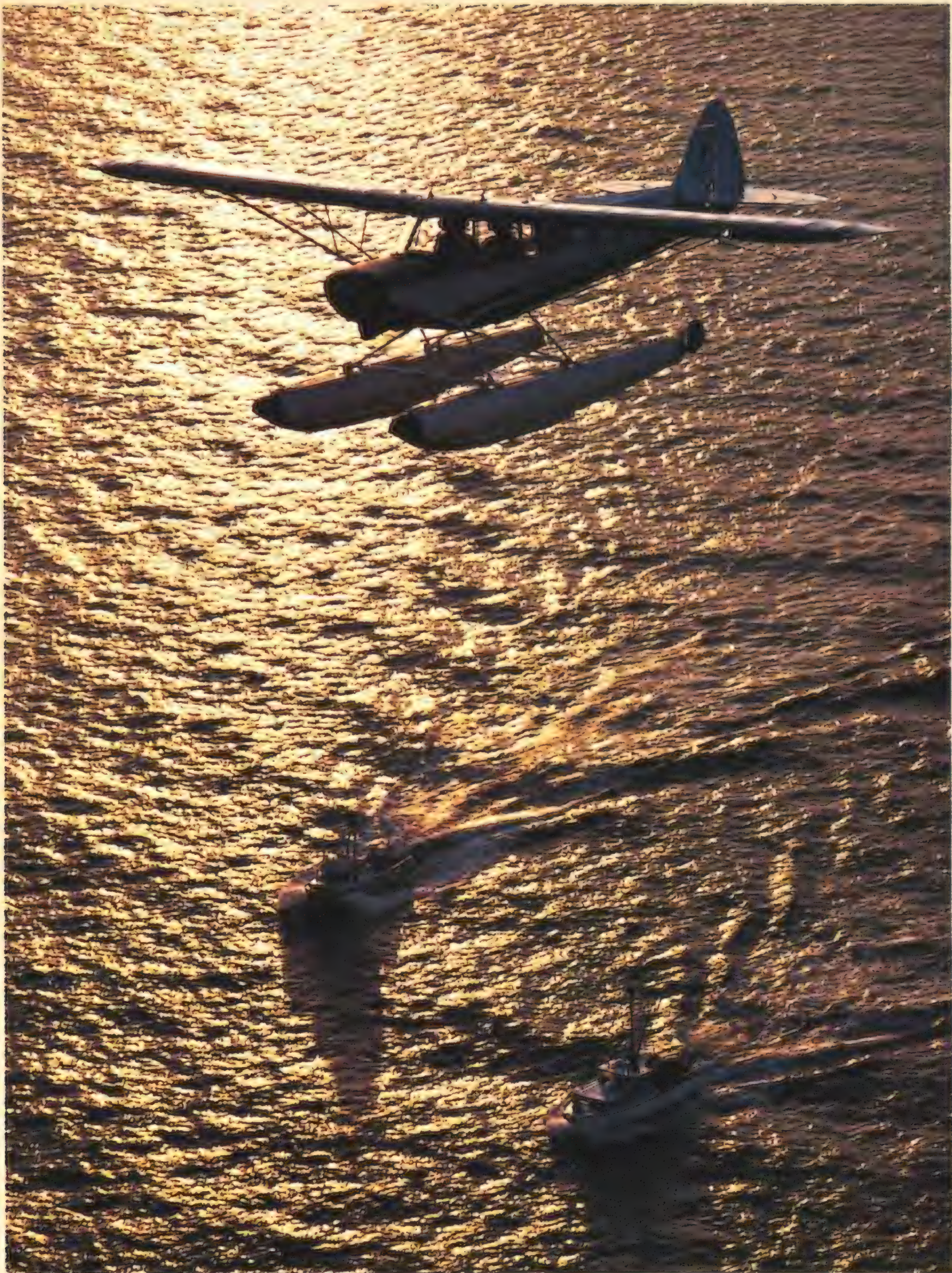
from the wavelets and whitecaps. I'm seeing maybe five percent of the fish Gowans reports. He's currently describing to his clients where all the other boats are concentrated. At least I don't have any trouble seeing the boats. As we dodge thick patches of fog, we see the other two spotters doing the same. Although they can't fly at the time of the opening, they can still tell clients where the fish were an hour earlier, and where they were headed.

Gowans remarks that there are good spotters and poor ones, just as there are good and poor fishermen. A good spotter must do more than look down and see fish. Handling an airplane has to be instinctive; the spotter has to keep his attention outside the aircraft, not on the altimeter or the turn-and-bank.

That evening, Gowans and I are sitting with Heil and Litzen in the restaurant-bar of Naknek's D&D Hotel. We're eating, not drinking, since everyone's flying tomorrow, and all three pilots are eager to talk about the spotter ban in Bristol Bay.

"With the stroke of a pen," says Litzen, "something we've been doing for decades to earn a living is suddenly illegal." Spotters can claim something of a tradition. Scott Kyle, a fish spotter out of Homer, has told me that in the 1920s, Russ Mer-

At the end of a long workday on Cook Inlet, Mike Litzen flies his Super Cub over the fishing boats heading home.





rill spotted from an open-cockpit Curtiss MF flying boat and communicated with fishermen by dropping notes or shouting as he went by.

The three spotters agree emphatically that the ban is not a conservation measure. Alaska Fish and Game biologists establish "escapement goals"—the numbers of salmon that must get up the rivers to spawn in order to maintain a healthy fishery. They then count how many fish are actually in the river headed toward the spawning grounds. When escapement goals are being met, biologists schedule an "opening" for several hours. At that point, it's catch as many as you can while you can. Heil

says, "Airplane spotting has less to do with how many fish are caught than it has to do with who catches them."

"The so-called safety issue was a big factor in the Board of Fisheries decision," says Gowans. There are disagreements about the importance of this issue, though all agree, with some qualifications, that spotting is dangerous. The first of the spotter bans in Bristol Bay followed a mid-air collision in 1988, when parts of airplanes flamed down into the midst of the fishing fleet. The latest ban followed a collision in 1995. This year, another mid-air in Prince William Sound during the herring season killed the president of the Alaska

Fish Spotters Association and his observer.

"If safety really were the issue, they'd ban spotting for herring," says Litzen. "That's just as dangerous." Gowans explains: "It's true that the fishery here is always on the verge of being out of control. A couple of years ago, when the mid-air occurred, it was out of control. There were 50 to 60 airplanes in a small area, minimum altitudes were constantly busted, and VFR [visual flight rule] minimums were ignored."

Litzen adds, "No matter how bad the weather, you'd always hear somebody start up, then someone else would go, and eventually they'd suck me out when



The Bristol Bay melee (left): The sky can get as crowded as the water. A trooper investigates salmon-filled nets washed ashore (right)—an illegal haul cut loose to avoid a fine or one boat's reckless severing of another's catch.

boundary. Some boats will pay a pilot simply for warning them when the state troopers are coming. I ask whether any of them have ever done that.

"Oh sure," says Gowans. "Just about everyone has occasionally said 'I see a cop coming around the corner, get back in.' But rarely for most of us."

Heil is indignant. "They've hung that on us as though it's been driven by us. Nobody's flying today's openings, but there are boats out there right now sticking their nets two or three clicks over the line to catch illegal fish because that's the game in Bristol Bay."

The real advocates of the ban seem to be other fishermen. "Those who don't use spotters resent those who do," Gowans says. "And there are more of them, so they have the political clout."

The problem is complex. Spotters claim they're merely another step in the normal evolution of technological devices, no different from bigger engines and boats, or twin screws, or sonar, or better nets. They make fishing more efficient. Traditionalist fishermen argue that the airplane is unfair because it cancels out the experience they've worked years to acquire. With a spotter, even newcomers can fish efficiently, because spotters report where the more experienced are catching fish.

In fact, the most recent ban was proposed by a fisherman, Sam Liberati, who worried primarily about the fisherman's liability in case an aircraft he hired crashed. But the chairman of the Alaska Board of Fisheries, John R. White, a dentist from Bethel, says that what convinced him to agree to the ban was the concept of "an orderly fishery," which is written into the law empowering the board. "Once the subject of a Bristol Bay ban came up in the board meetings, we heard lots of complaints from fisheries biologists and law enforcement people that they were unable to go out there and do their jobs safely," he says. "If the biologists can't do their jobs properly, then spotting



does become a conservation issue." The spotters acknowledge that the biologists and law enforcement people may be endangered, but they insist that state regulation of spotter activities will reduce the dangers.

Gowans shakes his head. "If we went back to 60 airplanes, I wouldn't be here. I wouldn't do that again."

I have my doubts. As we've been talking, they've been revealing, little by little, what keeps them in this business. Most say it's the money, but other reasons, more difficult to express, may be at work: the adrenaline rush of airplanes in close quarters, pride in the skills they sharpen to catch more fish than the other guy, the satisfaction of earning a good living at something they enjoy. "It gets in the blood" is a frequent comment. Gowans started in the business as a deck hand on a fishing boat. "I looked up there and decided that would be a lot more fun than slipping and sliding around in fish guts," he told me.

The next day, I'm scheduled to fly with the state troopers. Colonel John Glass, who heads the Division of Fish and Wildlife Protection, is visiting the King Salmon station, where the Bristol Bay patrols originate. I ask him whether he has, as the spotters claim, threatened to confiscate their airplanes if they're in the air over a fishery during an opening.

"It wasn't a threat," he replies. "We want to be sure they know what could happen. Just like the fisherman out

I'd have chosen not to go." Heil insists, however, that banning isn't the answer. "We've begged the state to regulate spotters in the same way they regulate boats, with permits and quotas and safety standards. We may be the only group in the country wanting more rather than less regulation."

Opponents have also accused the pilots of spotting cops instead of fish. The competition is fierce to be the first boat closest to the line where the salmon are entering the river. The difference between first in line and fourth can be \$15,000 versus \$500 for a single set of the net. Boats try to leapfrog one another, often straying over the legal

FRED HIRSCHMANN (2)



FRED HIRSCHMANN

there who crosses the line. His catch and even his boat can be impounded. That's not a threat. It's the law."

I remark that impounding an airplane for simply being in the air at a particular time and place seems legally questionable. "We could certainly seize it," he says. "Whether we can keep it is another matter. For a flagrant violation we'd put them out of the air." He allows that he'd have to prove that the aircraft's client was over the line and that the aircraft was communicating with the boat in the commission of an illegal act. Scramblers make the task more difficult, but scrambled signals can be de-scrambled. I ask whether he has such equipment and whether he would use it. "I won't answer that," he says.

A few minutes later, I'm walking with trooper Scott Gibbens toward his Robinson R-22 helicopter. If a helicopter can be called cute, this little two-seater is. Gibbens sings its praises: "It has a 160-horse engine, carries 30 gallons of gas, burns eight gallons an hour, and has a best cruise of 85 knots [98 mph]. All very comparable to the Super Cub, but with more versatility. The floats give it a bigger footprint for landing on the tundra and also help to make it more visible, an important advantage when you're mingling with a lot of spotter pilots who are looking down for fish instead of looking for other airplanes."

Half an hour later, on the north line at Egegik,

When Lori Egge isn't flying a Cessna 185 over Togiak herring, she flies tourists over Alaska in her Grumman Widgeon. But in New England, spotters Jonathan Mayhew (below) and John Betzner (opposite) were grounded for most of the season.

we look down on an immense tangle of boats swerving and maneuvering, running over one another's nets, fighting for position. There are 679 boats in the Egegik fishery, all crammed into the mouth of the river, and the majority try to fish the boundary line.

Gibbens looks for violators, checking his GPS receiver as we fly directly over the boundary under a windy, rainy overcast. Since we're flying during an opening, we don't expect to see spotter aircraft, and we don't. At one point we see another trooper in a Super Cub patrolling another section of the line.

If Gibbens were to see a known spotter in this space, he says he'd get the

registration number, go find the airplane when it lands, and impound it. What if the pilot wasn't spotting? "There's no other reason in the world for him to be here," Gibbens says.

The next morning, Dakers Gowans says, "Let's go fly an opening." When I ask whether he's worried about having his airplane confiscated, he replies: "I've talked to the FAA and to the state's assistant attorney general, and nobody really thinks they can do that. I guess we'll find out." I'm his innocent excuse for testing the system.

The activity in the fishery seems even more chaotic from the back seat of a Scout. Gowans explains what he'd be doing if he were spotting: maintaining altitude, looking for other airplanes, spotting jumpers, and reporting where boats are concentrated. He'd also be looking at other people's nets to see where the most fish are being caught.

On one of our passes, I see a helicopter about 300 feet below our 500-foot altitude, crossing our path. Hard

to tell for certain in this murky weather, but it looks like an R-22 with a red and white paint job—virtually certain to be trooper Scott Gibbens. I point it out to Gowans and he shrugs. I watch until the chopper disappears behind us, half expecting to see him pull up beside us in a few minutes, but we never see him again.

Anne Graham, a field officer for the Federal Aviation Administration and a



MICHAEL MELFORD

former fish spotter herself, understands the spotters' frustrations. Graham is the safety program manager for operations in the FAA's Anchorage office, and she agrees that the Bristol Bay mid-air collision in 1995 was not the major reason for the ban but provided a convenient hook for those who oppose spotters to hang their case on. A rash of complaints went to the FAA in Washington, D.C., and back to the Anchorage office. "I didn't recommend closure," she says. "I think spotting can be done safely within the regulations and guidelines."

Graham helped the spotters draw up a pamphlet outlining the main Federal Aviation Regulations they had to comply with: commercial certificate, second class medical certificate, flight review within 24 months, and 500-foot minimum altitude over vessels. The pamphlet also set forth criteria that the spotters suggested the state should adopt as law: appropriate lights, circling counterclockwise for orderliness and better visibility, maintaining altitude, and the expectation that all spotters will carry an observer. But the ban came anyway.

A couple of days later, I head up to Nikiski, a very small town on Cook Inlet, where I've arranged to meet Mike Litzen again. His large house overlooks a lake, where he ties up his superbly restored float-equipped Super Cub. Litzen also has two airplanes on wheels in his driveway, and there's a runway on that side of the house. He lives an airplane lover's dream.

There's no ban here, so we'll be flying openings. We've planned to take off at about 5 a.m., but fog shrouds the tree-tops. We hear a spotter on a neighboring lake take off, but 20 minutes later he's back. It's three more hours before the overcast has lifted enough for a navigable corridor.

Compared to Bristol Bay, the Cook Inlet fishery is very relaxed. Boats are spread over a much larger area, so there's no boat-bumping competition. And there are fewer airplanes. Perhaps that's why the custom here is to pay spotters

an hourly rate—usually \$150 to \$200—rather than a percentage of the haul. Since most spotter airplanes burn eight to 12 gallons of fuel an hour at an average cost of \$3 a gallon and spend an average of \$6,000 annually on routine maintenance and inspection fees, the net hourly is considerably less.

It's a bad day for spotting. Forest fire smoke is accumulating in the space below the overcast and limits our vision to what lies directly underneath us. Litzen can't even see where his boats are. We fly north-south in long sweeps, picking out occasional jumpers. My spotting rate for jumpers has vaulted to about 10 percent by now. No one is catching anything.

While Bristol Bay and Cook Inlet differ as salmon fisheries, they both differ greatly from the herring fisheries. Lori Egge doesn't do salmon spotting anymore. Not profitable enough. She went to Bristol Bay one year for salmon but didn't like it. "Too much muddy water and too much political controversy," she says. "Some of those fishermen wanted me to just spot cops." But she still spots for herring.

Asked whether spotting is likely to be banned in the herring fishery, she laughs. "In the herring fishery, all the boats use a spotter. Every one. You can't do without," she says. Herring are fished in clear-water bays, so spotters can see the fish most of the time. Salmon, on the other hand, are fished in silt-filled river mouths, and under those circumstances, spotters aren't as useful.

The herring fishery is just as chaotic as Bristol Bay ever was. In an area like Togiak, there can be 200 to 300 boats and 75 to 125 airplanes. Egge says the pilots arrange themselves in small

overlapping circuits at various altitudes over the boats—patterns the pilots call "beehives." The practice makes maintaining altitude every bit as critical as maintaining airspeed.

"And it's all so competitive," she says. "An opening in a place like Togiak can be as short as 20 minutes. That's the whole season. So you're either a hero or a zero." Egge contracts with two, sometimes three boats. That's average for most herring spotters. They each pay her 15 percent of their gross.

"This tends to be a boom-and-bust business, like farming," she says. "Two years ago, the price for herring was \$2,500 per ton. This year it's \$200." A good boat in a good year can expect to harvest a hundred tons in each of five locations for a gross of \$1.25 million at 1995 prices. In 1995 the pilot got \$187,000 per boat, but this year the figure dropped to \$15,000. According to legend (apparently credible since Anne Graham says she's seen pictures of the haul), one pilot made \$240,000 for a single set.

Two days later, I'm sitting in Plane Jane's Cafe at the Plymouth, Massachusetts airport, talking to Jonathan Mayhew, president of the Atlantic Fish Spotters Association. Mayhew had planned to take me swordfish spotting, but the weather isn't cooperating. With an overcast sky, the water would look like mud. Since swordfish are loners, it takes what East Coast spotters call a "show day"—relatively calm sea with some blue sky—before the fish can be spotted from the air, even those that grow to 700 pounds and 12 feet long.

Mayhew's Citabria sits forlornly on the apron below our window. It seems to sag from being earthbound, its 90-

gallon belly tank hanging just inches from the ground. This plane will fly for 14 hours, not counting reserve, a range necessary for hunting swordfish as far as 200 miles out to sea.

But the weather isn't the only reason we're sitting in Plane Jane's. We could be out spotting giant bluefin, except that spotters have been banned from General Category tuna fishing this year.



MICHAEL MSELFORD



NORMAN ST. PIERRE/NEW ENGLAND AQUARIUM

Aerial photos taken by spotters have helped oceanographers study the schooling behavior of bluefin tuna.

Captain R. Willie Clark and crew of the Coast Guard's Cape Cod air station patrol hundreds of square miles of ocean in a Sikorsky HH-60 (below).

The category encompasses all sorts of boats, from commercial skiffs to pleasure yachts, and is the largest in the Atlantic fishery, with about 12,000 permits issued annually. Permit holders can use any method—harpoons, lures, rods and reels, hand lines—until the category quota is caught. The fishermen who benefit most from spotters and do the most hiring of them are those who use harpoons—only about 50 license holders. It has been so successful a partnership that the 11,950 people using other methods find significantly fewer fish left for them. They resent the fishermen using spotters who, they say, take too big a bite out of the quota and shorten the season. So the National Marine Fisheries Service has responded to pressure from the majority and banned spotters in that category.

The spotters may fly for a separate harpoon-only category. But that quota is much smaller and the season much shorter.

Rebecca Lent, the National Marine Fisheries official who imposed the ban, admits that a proposal for the ban came from the fishermen. But she adds: "National Marine Fisheries also has an interest in the season lasting longer for the General Category because we gather data from those boats as part of our stock assessment program." The longer the season, the broader the spectrum of data they have for analysis.

John Betzner's airplane is also grounded. He flies a Cessna 172 with extra large wing tanks and a 20-gallon tank

that fits in the baggage compartment. Altogether, he carries 75 gallons for a solid eight or nine hours in the air. Mayhew and Betzner are exemplars of two different kinds of New England spotters,

those who fly to optimize their fishing and those who spot to support their airplanes. Mayhew, who also owns two fishing boats, is one of the former, Betzner one of the latter. But on the subject of spotter bans, they're united.

There's no real conservation issue here, since the quotas are absolute. If anything, conservation favors the spotters. Harpooning with a spotter is the only method that offers a chance of determining the size of the fish before it's caught. "We can't tell to within three or four inches," says Betzner, "but we can certainly tell the difference between a giant and one that's undersize."

Spotter income here is also boom-or-bust. Depending on quality, giant bluefin can be worth anywhere from \$2 to \$35 a pound, so a single 600-pound bluefin can be worth as little as \$1,200 or as much as \$21,000. The spotter's share would be a quarter of each boat's gross, and a spotter will contract with one boat during harpoon season and two or three boats during the General Category season.

One factor in this East Coast equation has no counterpart in Alaska. For the past five years, fish spotters have

been doing a volunteer aerial survey in collaboration with Molly Lutcavage, a New England Aquarium oceanographer. Seven spotter planes are equipped with laptops, each connected to a GPS receiver and to a hand-held 35-mm camera. When the pilot sees a school of tuna, he takes a picture and the airplane's position is automatically recorded along with the date and time. Later, computer lists and photographs are matched and analyzed.

Lutcavage is pleased with the results. She sees it as the first step in a new way to assess stocks, superior to current methods. And she is frustrated with National Marine Fisheries. "We've all learned that we can't do a good job on an aerial survey without spotter involvement," she says. "It would take us 20 years to be as good as they are at estimating how many fish are in a school."

This was to be the fifth and final year of the spotter survey, and therefore very important to the integrity of the project. But the ban is interfering. According to Mayhew, "Some anti-spotter fishermen have formed a sort of vigilante group for the purpose of reporting any spotter planes they see in the air, complete with video tapes. So we're not going to fly." Most of this year's data will be lost.

For the next few days, Hurricane Danny pushes enough of its sloppy weather up along the New England coast that there's no point in trying to spot for swordfish. So, interested in how the Atlantic fishery is policed, I fly with the Coast Guard, the primary on-site



MICHAEL Melford



Mike Litzen installed oversize windows on his Super Cub—the better to see fish, boats, and other spotters. If trends continue, he may be looking at nothing more than Alaska's famed scenery.

FRED HIRSCHMANN

enforcement agency here because most of the fishing occurs outside the three-mile line, in federal jurisdiction.

An HU-25 Falcon twin-jet with a crew of five is today scouting for violations of closed areas reserved for regeneration of various species. I sit in the jump seat just behind the pilot, Lieutenant Pete Conley, and the copilot, Captain R. Willie Clark, who is also commander of the air station. I'm waiting to see whether they'll be actively looking for spotters, but we overfly the tuna fleet without a glance. So I ask. Neither pilot is aware of the ban. Later, back at the air station, I don't find a single pilot who knows about it. Well, they know now. I tell myself I've done the spotters a favor. They were being good and no one was noticing. But it's clear that the Coast Guard has bigger fish to fry, pun intended. They're looking for violators like the boat they caught a few days ago with an illegal scallop catch worth \$262,000.

In an HH-60 Jayhawk helicopter the next day, Lieutenant Peter Hanlon of the Massachusetts Environmental Police, part of a cooperative agreement between the Coast Guard and the state enforcement agencies, echoes the Coast Guard pilots' unawareness of the spot-

ter ban. "Now that you mention it, I guess I haven't seen them around for a couple of weeks," he says.

However, when I ask National Marine Fisheries patrol officer Richard Touzos, he's very much aware of both the ban and the group the spotters call the vigilantes. "The industry is going to police itself," he says. "If there's strong enough evidence we'll prosecute. Basically, someone's going to have to come forward and let us know what's going on." I ask if he means informers. "Exactly," he replies. And once a spotter is arrested, he adds, "we'll make an example of them. We'll show that we mean business."

Peter Weiss means business also. He's been the leader in the fishermen's efforts to ban spotters. In a five-page letter to Rebecca Lent of National Marine Fisheries in March of this year, he accused the spotters of illegal practices and unethical conduct.

Some of the issues are clearly subject to interpretation. For example, Weiss says the spotters create havoc by directing their boats to schools already being fished. Mayhew says the havoc is created by the competitive nature of the industry and that the same havoc goes on when the spotters aren't

flying. Weiss says airplane spotting accelerates the catch. Mayhew says, "Each boat in the General Category can catch only one fish per day. Using an airplane just makes us more efficient, saves gas, reduces vessel wear and tear, and minimizes discarding of undersize fish." Grounding the airplanes in 1997 did not stretch out the season, as some had believed it would.

Other issues are harder to resolve. Weiss says that National Marine Fisheries policy is to spread the catch over the largest number of fishermen. Airplane spotting helps a small number of boats to get a larger share. (Lent clarifies that the policy is to spread the catch over the widest geographical and temporal range. She acknowledges that the policy favors the largest number of fishermen.) Betzner says the policy is flawed because it overbalances in favor of the majority in the General Category, who fish as a hobby. "Doctors and business executives with yachts want to fish for the giants with rod and reel, but that makes them commercial," he says. "You don't put an 800-pound tuna in your freezer. They sell it and pocket a big piece of change."

The arguments are far from over since the spotters will be challenging the ban in court. But on the plane home, I speculate about the future of fish spotting. The three caballeros from Alaska seem to agree that spotting is so pervasive and so important to the herring fishery that proposals for bans there will never get beyond the talk stage. They're less optimistic about the salmon fishery. Lori Egge says that if fish prices stay depressed long enough, spotters will disappear.

When I was planning this trip, Mayhew had told me that a ban was being considered, and he worried about what it might mean to spotters. "I hope you won't be coming here to write about the last gasps of a doomed occupation," he said. There were times, both in Alaska and in New England, when it felt something like that. ➔

MONSTER ENGINES

WHY THE ROAR OF THE MIGHTY RECIPS WAS SILENCED FOREVER.

by Bruce D. Berkowitz

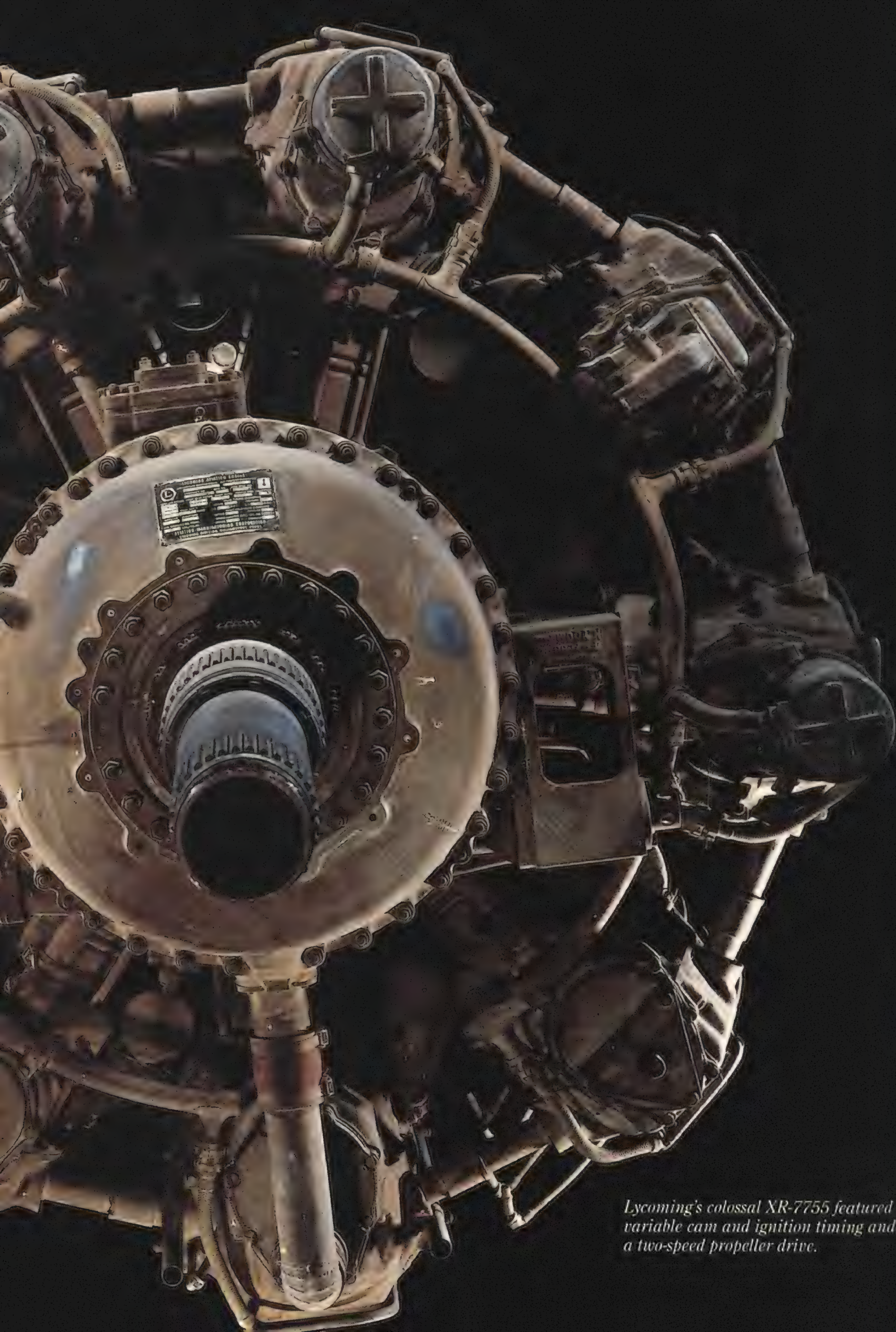
Color photographs by Eric Long

“**W**hat a racket that engine used to make,” recalls Waldo Bird. “The neighbors had an awful time. We built cement baffles that would reduce the noise so that it wouldn’t disturb the people on High Street. But the baffles wouldn’t last more than a week, I don’t think, before they disintegrated. That thing was *so* loud.”

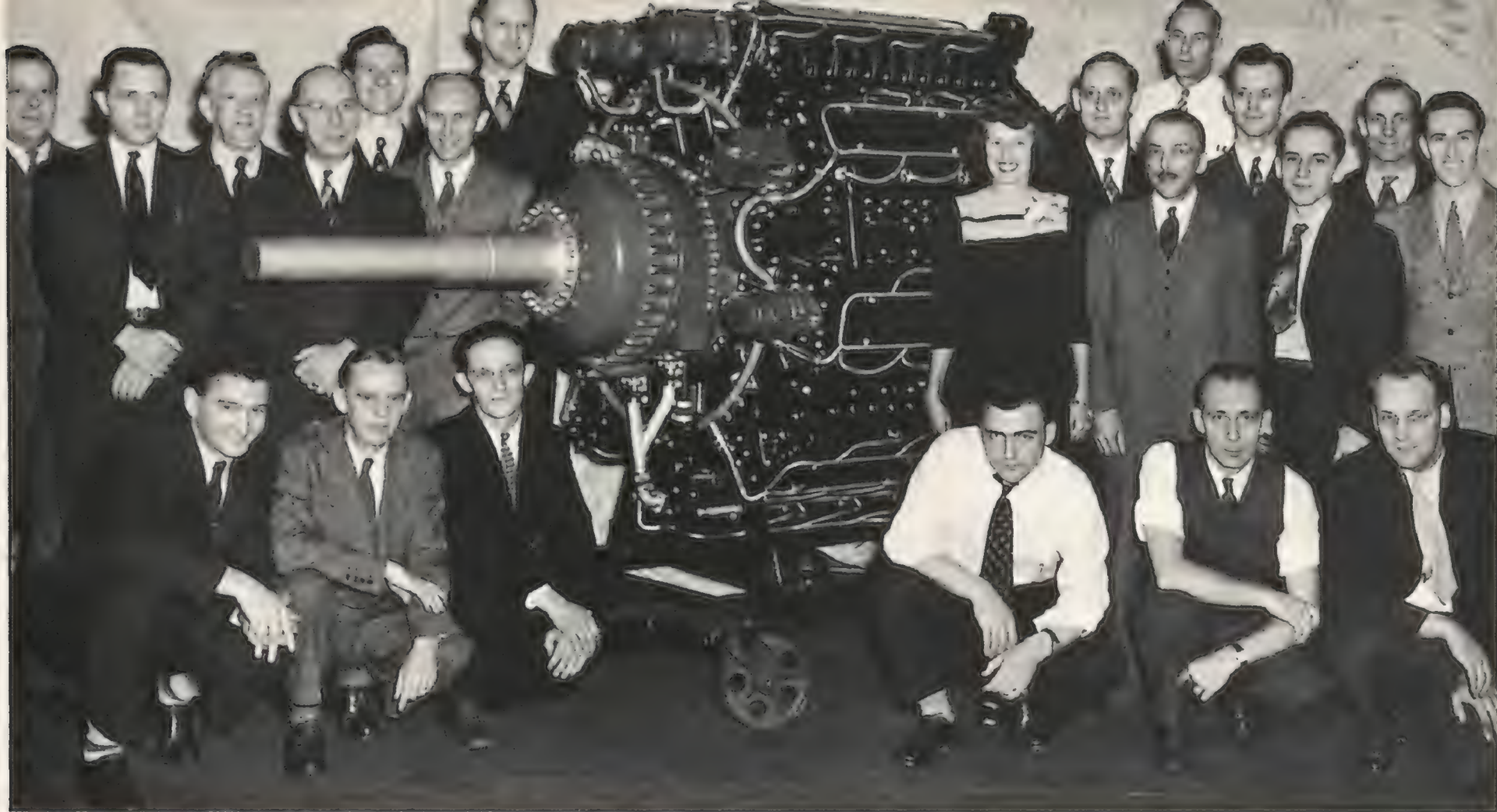
Bird worked for Lycoming Engines at the company’s Williamsport, Pennsylvania shops, and the sound of the XR-7755, or, as Lycoming brochures referred to it, “The World’s Largest Reciprocating Aircraft Engine,” is recorded forever in his memory. The engine’s 36 cylinders had a displacement of 7,755 cubic inches, or roughly 20 times that of a typical automotive V-8 engine. It had two starter motors, and the water pump circulated coolant to its cylinders at a rate of 750 gallons per minute, about the same as the average fire engine. At 10 feet long and five feet wide, it could fill a small room.

Lycoming began work on this giant in 1943, but by 1945 the project had been halted. Despite its incredible size, the 5,000 horsepower it had for takeoff, its unforgettable roar, and the sophistication of its design, the mighty XR never powered an airplane. Only two were built, and one of them resides at the National Air and Space Museum’s Garber facility in Suitland, Maryland. Its sheer size comes as a shock to first-time visitors, and in that odd way, even in silence it is deafening.





Lycoming's colossal XR-7755 featured variable cam and ignition timing and a two-speed propeller drive.



PAUL M. MCBRIDE COLLECTION

The era spanning the 1930s and '40s was a great time to be an engine designer. All the brightest engineers were designing reciprocating aircraft engines—at Rolls-Royce, Napier, BMW, Lycoming, Curtiss-Wright, Pratt & Whitney, and about a half-dozen other companies in Europe and the United States. World War II unleashed millions of dollars for propulsion development, and even as the war was raging, the engine companies had their eyes on the postwar commercial market.

The result was a generation of monster engines—exquisite power plants built with the precision of a Swiss watch but brutish enough to generate up to 5,000 horsepower. These engines could have powered the aircraft that fought the cold war. They could have been in the airliners of the 1950s, '60s, and early 1970s. Many would probably still be flying. Yet today the giant reciprocating engines are nothing more than a memory to those who built them and a point of historic curiosity to those who are drawn to the poignancy of their fate. “We get questions about these engines all the time,” says Rick Leyes, curator of aeronautical propulsion at the National Air and Space Museum. “People want to know the story behind them.”

At the very time they reached their peak of sophistication, reciprocating engines were encountering their first competition with turbojets, which had begun to appear in the late 1930s (see “Gentlemen, I Give You the Whittle Engine,” Oct./Nov. 1992). Billions of dollars in sales, the futures of several large corporations, and the careers of thousands of engineers and technicians were at stake in the battle between jets and reciprocating engines. Yet in truth, each type of engine was battling with its own limitations as much as it was competing against the other's strengths. For jets, the question was whether anyone would ever be able to make the engines reliable and economical. For reciprocating engines, the question was how much more performance could be squeezed out of them.

To give them their due, reciprocating engines had come a long way in just four decades. The engine Charles Taylor built for the Wright brothers' 1903 *Flyer* weighed 180 pounds and on a good day could produce 12 horsepower. That's a power-to-weight ratio of about .07 horsepower per pound.

Had Lycoming's engine powered the Convair B-36, the employees at the firm's Williamsport, Pennsylvania plant would have begun producing thousands of them. Though the engine was a successful design, it never flew.

Just 40 years later, the typical aircraft engine had a power-to-weight ratio of .8 horsepower per pound—a tenfold improvement. And the gains were achieved incrementally: First the designers might smooth out the induction system, then in the following year add another stage to the supercharger, and so on. It was in this manner that Rolls-Royce's classic Merlin, the engine that powered Mustangs, Spitfires, and Hurricanes (and after the war, civil airliners), grew from 1,000 horsepower to 1,700 horsepower during a production run of more than 20 years.

But the overall efficiency of piston engines suffers, in part, because they produce a lot of internal friction. The Merlin, for example, actually generated about 2,000 horsepower, but its inner works—a supercharger, two camshafts, 12 pistons, 24 valves, and scores of gears and shafts—all absorbed power. Jets, which have far fewer moving parts (all of which rotate instead of moving back and forth) and a more efficient internal airflow, produce much more power per pound. But in the beginning, jets weren't very reliable; the science of metallurgy had not advanced enough to cope with the jets' high combustion temperatures and unprecedented rotational speeds. Once engineers figured out how to beat the reliability problem, the contest was over. And the bigger the engine, the bigger the advantage jets had over pistons, which still survive in the low-cost, low-power niches. Until the issue was settled, though, the efforts to keep reciprocating engines competitive produced some magnificent machinery.

Much of Derby, England, has changed little in 50 years. Rolls-Royce still occupies many of the low, red-brick shops that date to World War II, when Ken Fozard worked on the Crecy and the Eagle-22, Rolls-Royce's last reciprocating engines. Fozard is the kind of guy you would like to

meet in a pub. He's a big man who laughs a lot and slips a few expletives into his tales. Newer employees at Rolls-Royce address him as "Mr. Fozard." Out of earshot, though, he's "Fozzie."

The Crecy enjoys a mystique among aircraft aficionados, partly because the engine—a 1,593-cubic-inch supercharged two-stroke-cycle V-12—was so radical. Also, the program was canceled before it was completed. So, as in the case of athletes or rock stars cut down before hitting their prime, we can only fantasize about how well the Crecy would have performed in a production airplane.

The basic concept behind the Crecy bounced around for years before there was a real opportunity to try it. Sir Harry Ricardo, the guru of British internal combustion engine design, was long intrigued by two-stroke-cycle engines and helped to champion their cause. Most aircraft engines employed a four-stroke cycle, in which power is produced on every other downward stroke of the piston. Two-strokes produce power on every downward stroke and offered the po-

called the Aeronautical Research Committee decided the nation needed a fighter that could scramble on short notice and reach high altitude in time to intercept bombers. For such a fighter interceptor, the British needed a sprint engine—hence the Crecy.

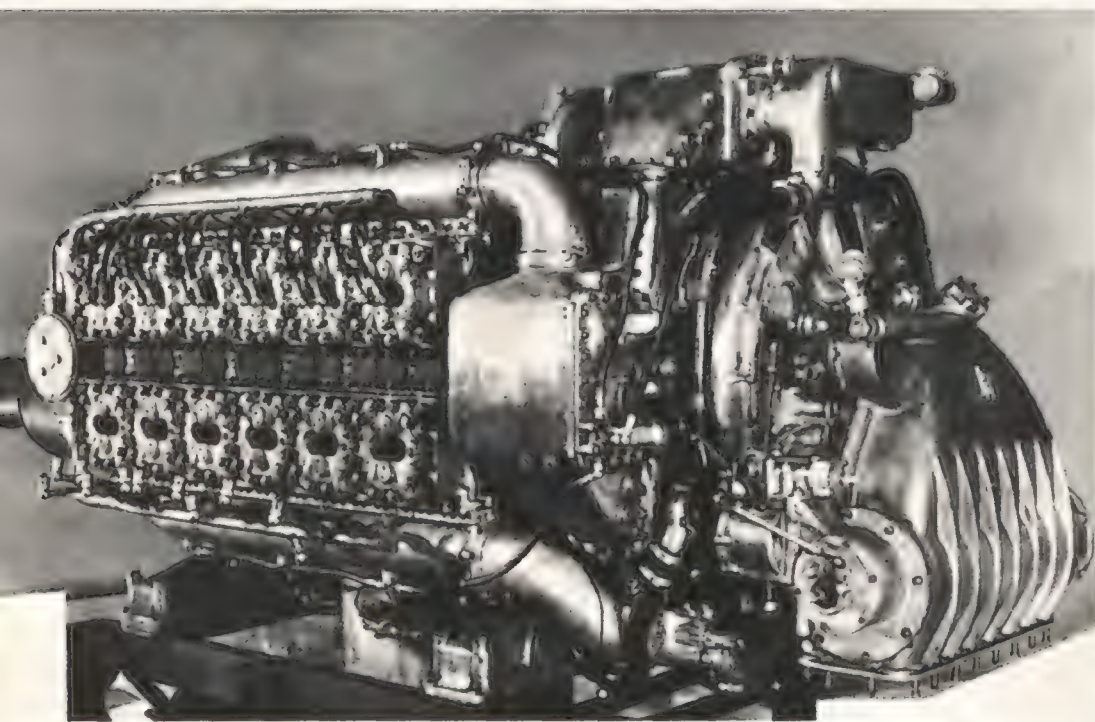
According to people who knew the Crecy well, the most distinctive feature of the engine was its sound. Being a two-stroke, the Crecy's exhaust valves opened while there was still significant pressure in the cylinder. The effect was akin to a rifle shot—or, when the engine was running at full power at 2,750 rpm, 33,000 rifle shots per minute. Fozard recalls the tests. "The sound of it was enormous," he says. "They reportedly said that when we ran it with an open exhaust during the war, the air raid sirens went off in Nottingham," 15 miles away.

Rolls-Royce worked on the Crecy from 1937 to 1942, dropping the project only when its managers decided that jets were the engines of the future. To hedge its bets, though, Rolls-Royce reassigned most of the Crecy team to work on a more conventional large engine. The 3,500-horsepower Eagle-22 (not to be confused with the 350-horsepower Rolls-Royce Eagle, which powered Alcock and Brown on the first nonstop transatlantic flight in 1919), was aimed at the problem of fitting more cylinders into a single engine.

Pointing to a piston from an old Merlin, Fozard explains, "With a piston engine you can't keep going to a bigger cylinder. There's a limit." The fuel-air mixture in a reciprocating engine does not explode; it burns along a curved front, expanding from the spark the way dry grass burns if you put a match to it. As you increase the diameter, or bore, of a cylinder, the combustion process takes longer to complete and is less efficient. Also, as you move to a larger cylinder, the mass and surface area of the piston increase exponentially, which means even more vibration and more friction. As a result, the practical upper limit to the bore of a cylinder is about five or six inches. As an engineer might put it, reciprocating engines do

not "scale" well.

The only solution is to add cylinders, but this presents its own problems. One is packaging: The engine needs to fit



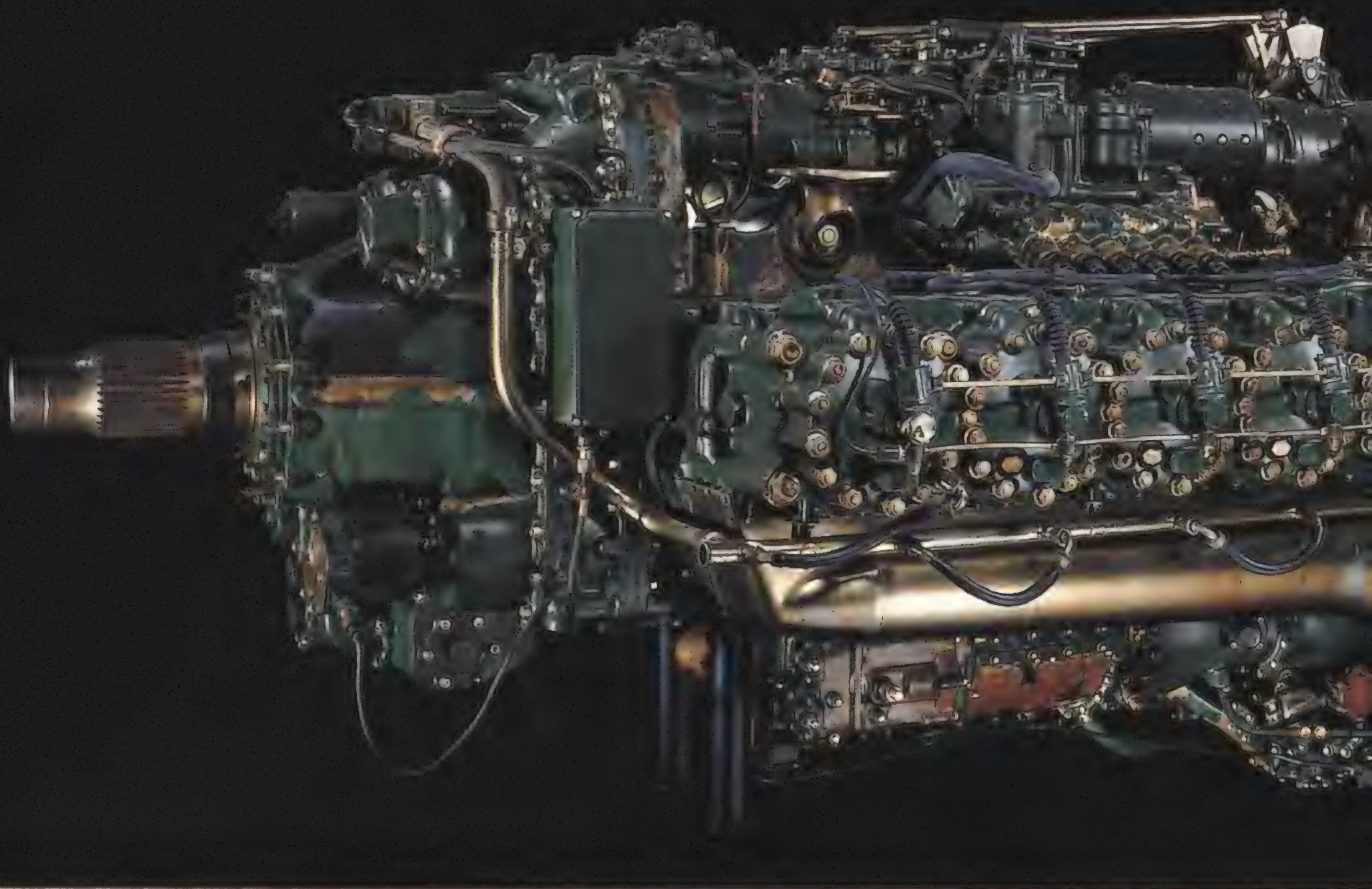
NASM (2)

tential to generate a lot of horsepower from a small engine. Crecy proponents claimed their engine could produce as much power as a Merlin at one-third the weight.

Andrew Nahum, curator of the aeronautical collection at the British Museum of Science, wrote in the April 1997 issue of *Technology and Culture* that the origins of the engine are rooted in the British-developed radar of the late 1930s. In order to make best use of its secret defensive sensor, a government group

Like a pair of 12-cylinder engines driving a single gearbox, the Rolls-Royce Eagle was an H-24. Its sleeve valves opened into the sides of the cylinder wall, unlike poppet valves that opened at the top. The Eagle powered early Westland Wyverns (right).





into the aircraft, so it can't grow too long. And in long engines, crankshafts tend to twist. This explains why monster engines tended to have such exotic configurations.

Most automobile engines today are inline fours, V-6s, or V-8s. A typical aircraft engine of the 1940s was a V-12 or a radial 14 or 18. Monster engines, on the other hand, took forms like Allison's V-3420 and Daimler Benz's DB 610. Both were W-24s: two V-12s mated in a common crankcase. Lycoming's 36-cylinder X-7755 and BMW's 28-cylinder 803A were radials, each consisting of four rows of cylinders. Wright's R-2160 took the top honors with 42 cylinders.

The Eagle-22 was an H-24, or two flat 12s stacked and geared together. As reciprocating engines go, it was a good one, powering the Westland Wyvern fighter after the war, but it was soon replaced by the enormous Armstrong Siddeley Python turboprop. By that time the contest was over and Rolls-Royce had moved on to turbine engines. But Rolls had a rival: During the heyday of reciprocating aviation engines, Rolls-Royce was embroiled in a GM-Ford-style rivalry. The competitor was D. Napier and Son, based to the south in Acton, outside London.

Napier devotees, who often feel like the neglected second son, inevitably consider the Eagle-22 a knockoff. Napier had designed its own H-24, the Sabre, a full four years before the Eagle-22. Fozard insists the Eagle-22 was an original design and still has some original drawings leading up

to the engine's final configuration, showing the various combinations of layouts Rolls-Royce considered. But Geoff McGarry, who began working at Napier in 1939, recalls, "The Air Ministry wanted a 2,000-horsepower engine. They had a thousand. They wanted 2,000. Where did they go? They came to Napier."

When reminded that Rolls-Royce got the opportunity to develop the Eagle-22 in part because the Sabre had some severe teething pains, Napier proponents are prone to recall some engines that Rolls-Royce would probably like to forget. "What about the Vulture? What about the Vulture?" insists McGarry, citing an aptly named engine that Rolls-Royce built for the twin-engine Avro Manchester bomber. The Vulture was an X-24 made of two V-12s driving a single crankshaft. No one ever figured out how to get the engine to run reliably, though, and eventually the Royal Air Force gave up on it. Instead the RAF installed four Merlins on the Manchester, which was renamed and became the famous Lancaster of World War II.

Today, companies rarely give up on an engine, and they have computers to help sort out problems. One of the most remarkable facts about the monster engines is that all of them were designed using slide rules, paper, pencils, and plenty of trial and error. "The drawing offices were vast. We took over the Eastman's Laundry next to the Acton works, all four floors," recalls Alan Vessey, another Napier veteran, describing Napier's growth during the war. "It was converted



to drawing offices with many hundreds of drawing boards."

Every piece required a detailed drawing. "There would be a gear-and-drives man," recalls Fozard, explaining how a reduction gear system was designed. "He'd be given an interface, saying 'Here's where your gearbox hangs on, here's the mounting points and size, and you cannot go any farther than that because the supercharger is going on the back. Now get on with it.'" Like monks working on illuminated Bibles, these people would be drawing a given part most of their lives. There was also a pecking order. "The worst bloody thing you could ever be involved in is oil systems," continues Fozard. "Never be a designer of oil systems, because you'll be the one who's always taking the crap."

Rolls-Royce moved on to jets, but Napier was determined to stick with pistons for at least one more round after the war. Not surprisingly, Napier had a reputation for baroque engineering, and perhaps jets looked too

simple. McGarry admits, "Napier engines were quite complicated. We seemed to revel in complicated designs." So it was natural that the Nomad, a 12-cylinder, two-stroke diesel "compound engine" that the National Air and Space Museum's Garber facility once labeled as "the most complex aircraft engine ever designed," was a product of Napier.

The idea behind the compound engine is to capture as much energy as possible before it leaves the engine. In a typical reciprocating engine, a significant amount of energy escapes through the exhaust, and in some cases, the exhaust even produces a modest amount of thrust. The propulsion effect resulting from the hot gas blasting out the stub exhaust ports on an engine such as a Merlin, for example, could typically add 10 percent to the thrust of the engine-propeller combination. The Crecy derived a full third of its thrust from its memorably explosive exhaust.

For a brief period in the late 1940s, companies thought they could exploit exhaust energy even further, and the compound engine provided a means to derive energy from ex-

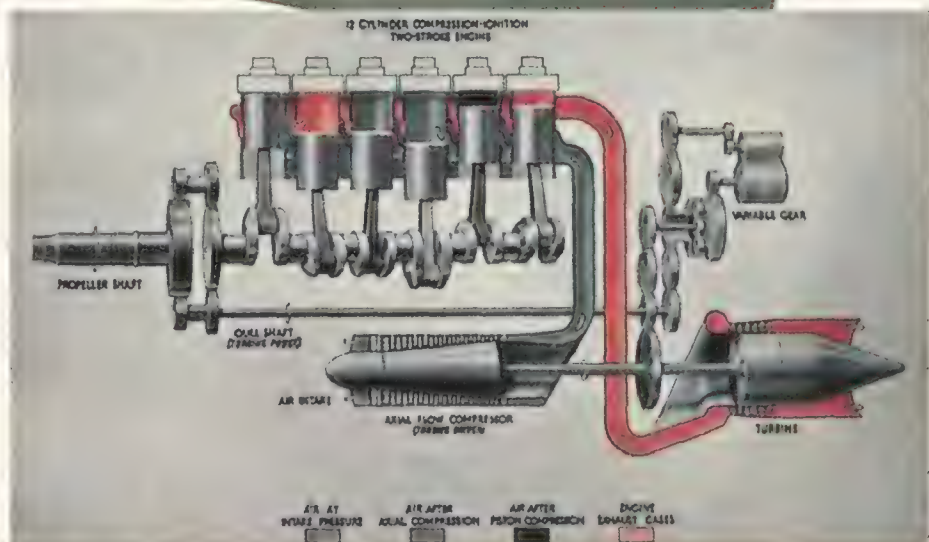
panding combustion gases first from the pistons, then from a turbine. In the Nomad, the exhaust ducts were routed directly to a turbine that drove both a supercharger and the propeller shaft. The operator could adjust the throttle and the mechanical links to the turbine to get the optimal mix of power, supercharging, and free-flowing exhaust. The Nomad was designed for maximum fuel economy rather than top speed because reciprocating engines are limited by their use of propellers.

The Nomad at the Garber facility is gorgeous. Napier was well known for preparing special engines for exhibit, but even run-of-the-mill Napiers had nicely polished camshaft covers, with every bolt—and these engines have hundreds—peened down fast with a hammer so it wouldn't budge.

But the beauty of Napier's engineering was surpassed by the ineptitude of its management, and the Nomad was doomed. A Napier brochure from 1951 tried to make the case that a Nomad-powered airliner was not only more fuel-efficient but faster than a jet. A jet airliner bound from London to New York, the brochure argued, would need to stop for fuel and customs in Newfoundland, adding to the flying time, whereas the miserly Nomad could make the trip nonstop. But aircraft designers are not idiots. They simply built much bigger jets



Perhaps the most complex aircraft engine ever built, the Napier Nomad at the Museum's Garber facility (above) was designed to be fuel efficient, a point the company made to airlines in its sales brochures (right). Napier argued that jets would have to stop for fuel, whereas its fuel-stingy propeller-driven types could cross the entire Atlantic nonstop.





COURTESY JOHN STROUD/BOAC

with larger fuel tanks and proportionally longer range.

The Nomad never flew in commercial service, and when the RAF decided to use Rolls-Royce Griffons rather than Nomads in Shackleton bombers, Napier shut down the Nomad project. The company began developing helicopter turboshaft engines and eventually faded from the aviation scene. Today the Napier name lives on in turbochargers sold by European Gas Turbines. Other companies that were slow to react to the jet revolution met a similar fate.

Long before the onset of the turbojet, Chrysler decided to get into the aircraft engine business. Like other engine makers, the company thought that after the war, airlines would buy large reciprocating engines. And the Army encouraged Chrysler, reasoning that even if the firm didn't know airplane engines, it did know mass production, which is a handy resource in wartime. To appreciate the difference in scale between aviation engine production and automobile engine production, it helps to recall that the largest run of any aircraft engine in history was about 178,000 copies of

Chrysler built a 16-cylinder inverted V of astonishing sophistication that could produce 2,500 horsepower, but when the engine was grafted to a P-47 for tests the results were uninspiring. NASM owns this example; Chrysler has another. The British launched transatlantic jet service in October 1958, and the age of the recip ended (above).

Pratt & Whitney's R-1830 Twin Wasp. By 1945, Chrysler had manufactured 10 million automobile engines.

The result of Chrysler's effort was the IV-2220, a 2,500-horsepower, water-cooled, inverted V-16 initiated in 1941 (and later designated the XI-2220). Its most notable feature was Chrysler's unique solution to the problem of coupling many cylinders to a single crankshaft. To re-

duce the troublesome torquewise whiplash at the ends of the long crankshaft, Chrysler put reduction gears to drive the propeller in the *middle* of the engine, rather than the front or back. In effect, the engine was two V-8s mated nose to nose in a slender form just right for a fighter.

In 1945 Chrysler flight tested the IV-2220 in two modified P-47s, which in hindsight seems an odd choice—a fat fuselage built for a large radial engine. With the IV-2220 aboard, the airplane looked like it was missing some parts. Without the advantages of optimal cooling aerodynamics, the airplane offered no performance advantage over the original radial engine, but if it had been given a P-51 airframe with its slick radiator as a test mount, who knows what the results might have been? When World War II ended, the IV-2220 project was canceled, and most of the engineers went back to designing cars. The engine has a special place in Chrysler's history because it was the company's first "Hemi"—it had a hemispherical combustion chamber with the spark plug in the center, allowing the fuel-air mixture to burn more quickly and evenly. Chrysler later applied the feature to a large automotive V-8, and in the 1950s

NASM



and 1960s, "Hemi" and "Chrysler" were synonymous in motor racing. Recently, Chrysler acquired a surviving IV-2220 and began restoring the engine for display. Some retired employees met for a reunion last summer and got a preview of the restoration of the engine they had worked on.

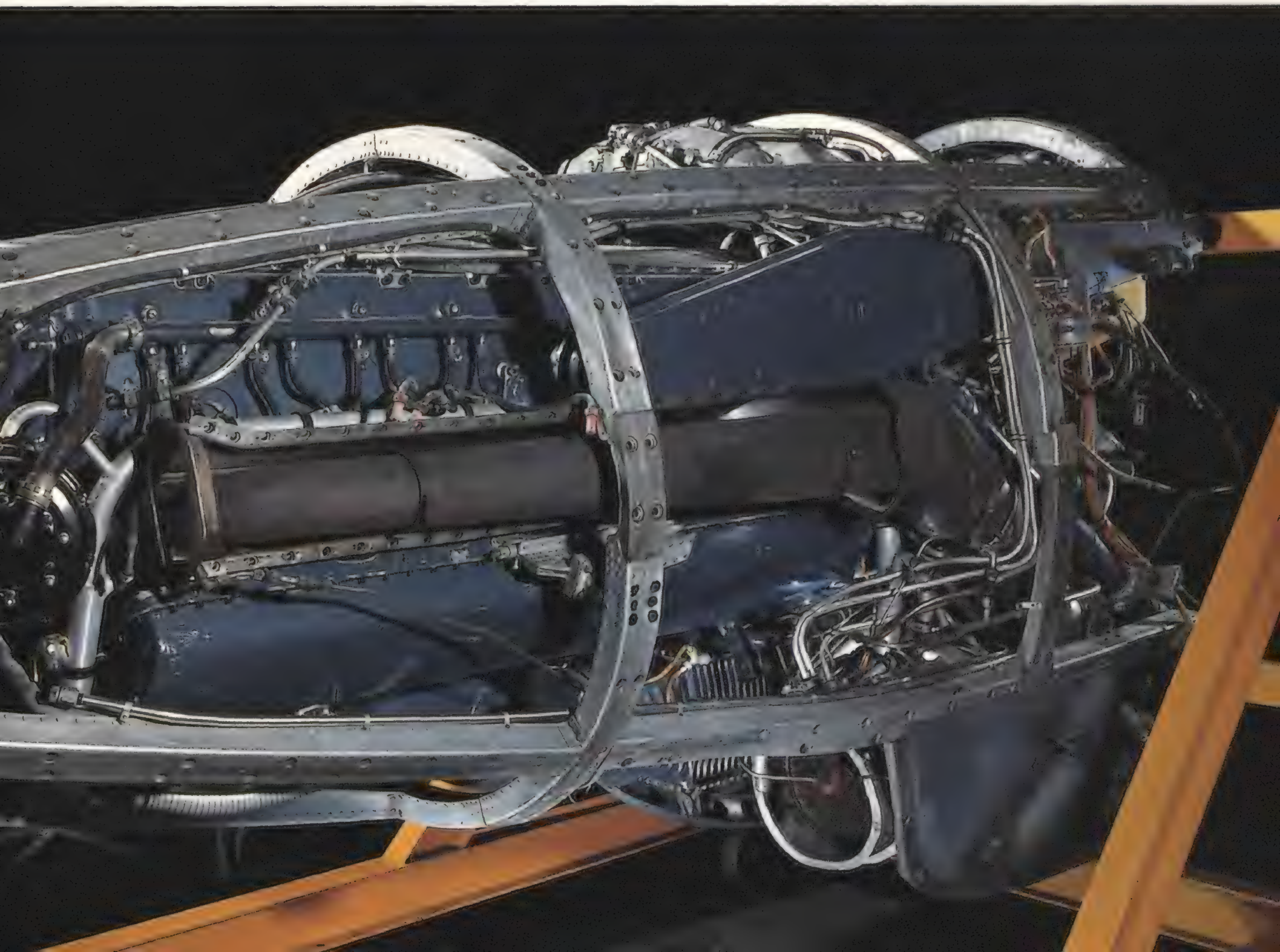
"It's *long*," said former technician Cliff Elliott, sounding like a proud parent whose son had grown a couple of inches during summer camp. "We were really pushing the envelope," said Bill Chapman, remembering the tests he ran on the engine. "We would burn pistons, break rocker arms, had trouble with valves, just a lot of things. Everything had to be developed as we went along."

The IV-2220 may have had as much impact on who designed engines at Chrysler as on how they were designed. Jack McCullough recalled that during the course of the IV-2220 project, "there was a lot of female help. When I came into engineering there weren't many women working at all, other than in a secretarial capacity. This project had a lot of women doing mathematical procedures, and a lot of women who rolled up their sleeves and ran test engines. When ethylene glycol sprayed the room, they got wet too. As a result, I think we saw a lot more female engineers postwar at Chrysler than pre-war. I don't recall how many we had. I had

just gotten married and wasn't allowed to look."

Not all large engines were doomed to obscurity. Some were mass-produced and were quite successful. The Wright R-3350 survived the end of the war to power airliners, as did Pratt & Whitney's huge R-4360 "corncob." But most monster engines have vanished. Crecys and Eagle-22s, for example, survive only in photographs and old drawings. The IV-2220 found a good home back at Chrysler, but like the one at the Garber facility, it will never run again. The engine would have to be rebuilt, there are no manuals for it, and no one is sure if anyone could reassemble it.

Technologies have a way of coming to an end gradually and without official notice. The horse-drawn era gave way to steam, which was slowly supplanted by internal combustion. In the transitions, there is an awkward phase when the outmoded technology reaches a peak of sophistication just in time to be retired, and some of the best examples of the art come to symbolize a dead end. Horses and steam locomotives evoke memories and affection, just as the sounds of the surviving reciprocating aircraft engines draw loving crowds at airshows and air races today. In the end, the monster engines have become silent monuments, preserved to be viewed and studied but never to be heard at full song. —





SYGMA NEWS AGENCY (2)



>SIGHTINGS<

In 1984, after being forced out of a distance race due to mechanical failure, a cohort of ferry pilot Robert Moriarty suggested their next bid for glory should be to fly their Beechcraft Bonanza through the arches of the Eiffel Tower.

"A walk around the tower showed me the flight might actually be easier than the carrier landings I made as a Marine aviation cadet," Moriarty writes. "At one end of a mile-long grassy strip lay the Ecolé Militaire. If I flew low over the city and dipped down to treetop level down the strip, I'd have a 30-second lineup for the tower entrance. The arch is almost 200 feet high and 250 feet wide, so my 35-foot wingspan would fit easily. Once through the tower, a slight climb would clear the open area between the buildings of the Trocadero Museum."

With news photographers stationed around the tower, Moriarty swooped through the arch at 11:15 a.m. on March 31. "Someone has flown through the Arc de Triomphe with mere feet to spare," Moriarty writes. "In comparison, the Eiffel Tower made the aircraft carrier Lexington look like a postage stamp. You could fly a 747 through the Eiffel arch."



Return of the Hunters

The Hunters by James Salter.
Counterpoint, 1997 (originally published 1956). 233 pp., \$22.00 (hardcover).

The MiGs came out of airfields in China in formations called bandit trains, sometimes led by a pilot dubbed "Casey Jones." The Americans waited on their side of the Yalu River and when the MiGs arrived, they fought. For 30 months, air-to-air duels took place over the northern rim of Korea in a sector that the press dubbed MiG Alley.

The term never appears in James Salter's novel about men flying F-86 Sabres in that air-to-air campaign. In fact, the term "F-86" never appears either. And although *The Hunters* is about the pressure on a pilot to shoot down five enemy aircraft and become an ace, the word "ace" appears only three times in this 100,000-word novel, and only within the tight, sparse dialogue of men conversing about their competition to excel in the air.

Long before Tom Wolfe coined "the right stuff," James Salter wrote of the stuff it takes to be a fighter pilot. In his world, complex men face different demons, but all are bonded by one goal, the be-all and end-all of their lives—to shoot down MiGs. Salter's protagonist, Cleve, tells a Japanese girl, "...if you shoot down five planes you join a group, a core of heroes. Nothing less can do it."

But anyone looking for a men's adventure tale or a Clancy-style military techno-thriller ought to skip *The Hunters*. This book is neither. It is a real novel in the finest sense—a lean, touching tale written by a man who fought MiGs and then went on to become a literary figure.

James Horowitz was his name. The son of a distinguished West Point graduate, he too went to the U.S. Military Academy and emerged in 1945 in a class that produced many legendary fighter pilots—Frederick "Boots" Blesse, Devol "Rock" Brett, Jack Broughton, Leonard W. "Bill" Lilley. As a fighter pilot with the 335th Fighter-Interceptor Squadron in Korea, Horowitz shot down a MiG-15 on July 4,

AF COLLECTION/NASM



1952. Outwardly a performer in the macho world of air aces, Horowitz was secretly writing.

The Hunters was published in 1956, while memories of the Korean war were still fresh. Many in the Air Force played a guessing game. Who, they wondered, were the real-life fighter pilots that the characters in the book were based on, and who was the real-life fighter pilot writing under the name James Salter? Curiosity focused not on the book's protagonist, Cleve, but on its bad boy, Pell—the brash youngster who risks the lives of his wingmen to become an ace. The real-life Pell is still alive today and is still disliked by some who flew with him.

After nine years in the Air Force, Major James Horowitz resigned his commission and changed his name to James Salter.

Salter would prefer to be remembered for novels like *A Sport and a Pastime* (1967), a tale of a young man and woman discovering the real France. His autobiography, *Burning the Days*, was published last September by Random House and includes a chapter about real-life F-86 flying in Korea, "A Single Daring Act," which was published in *Air & Space/Smithsonian* (Oct./Nov. 1991).

Shortly after its publication, *The Hunters* was made into a movie with Robert Mitchum (Cleve) and Robert Wagner (Pell). Hollywood's version had nothing to do with Salter's story and is eminently forgettable.

For years, Salter refused to allow *The Hunters* to be reissued. The book was rife, Salter said, "with youthful excesses, a faint superiority, or even snottiness to [its] tone." Only at the urging of publisher Jack Shoemaker of Washington, D.C.'s Counterpoint, a small literary press, did Salter relent.

At \$22.00, the 233-page, six- by nine-inch book is typical of the downsized American volumes filling our bookstores as the price of paper heads for the stratosphere. This always was a slim story that can be read in one sitting. Today, plenty of F-86 Sabre pilots from the Korean war are doing just that, seeking to find themselves. Without revealing its secret, I can say the novel is so universal that all of us—not just Korean war pilots—can find ourselves in its story.

—Robert F. Dorr is the author of several books about aviation history, including *F-86 Sabre and Air War: Hanoi*.

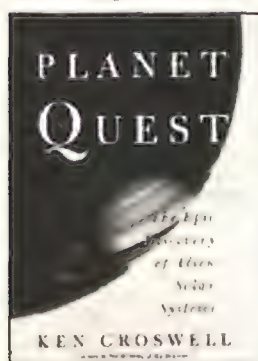
Planet Quest: The Epic Discovery of Alien Solar Systems by Ken Croswell. *The Free Press*, 1997. 312 pp., \$25.00 (hardcover).

For life as we know it to exist elsewhere in the universe, it most likely would live on the surface of small rocky planets like Earth. This simple assumption has propelled many astronomers to search for other planetary systems. Ken Croswell's engaging new book, *Planet Quest*, reviews the fascinating and often erratic journey astronomers have made to finally come to the very recent realization that, yes, there is evidence for other planetary systems...probably.

Croswell tells a candid and vivid story of the search for life on other planets, and then the search for other systems of planets. He lays out the carcasses of present and past careers devoted to the search—and shows how so many of those careers were misled. It all demonstrates that astronomy is a very human and chancy business.

Astronomers today have the tools to measure the excruciatingly minute periodic shifting of a star in space caused by the gravitational influence of invisible masses of planetary dimensions. But are these masses planets or extremely small stars? How does one distinguish between the two? These types of questions keep Croswell's narrative lively. Thus far, no Earth-type planet has been detected around a solar-type star. What have been found are planets ranging in size from Jovian-scale to hundreds of times larger. This is a good start, and Croswell makes the most of it by arguing that complex life on Earth-type planets requires the existence of Jovian-type planets to act as cosmic brooms sweeping the inner system clear of marauding comets that otherwise would have smashed into the smaller planets, destroying any life struggling to survive on them.

Croswell demonstrates viscerally how delicate the balance of life is here. He shuns questions of how life begins or



evolves, dodging the debate over the direction of evolution: Given that life can exist, will it naturally become self-aware and intelligent and venture out into the universe? He does envision a future in which at

least one life-form performs this last act: humans. Among those who argue this point, Croswell is one of the most sensitive and effective.

—David DeVorkin is a curator in the space history department of the National Air and Space Museum.

Heaven Next Stop: A Luftwaffe Fighter Pilot at War by Gunther Bloemertz. *Howell Press*, 1997. 192 pp., \$29.95 (hardcover).

What happens to dashing fighter pilots when their side loses the war? Gunther Bloemertz was one of the best, a member of the Luftwaffe's "Abbeville Boys," whose yellow-nosed FW-190s dominated the skies of Northern France during World War II. Their aerial heroics are not the most gripping thing in this memoir, however.

Instead, it is the author's vivid accounts of the defeat, total and crushing, of Germany's air force and Germany itself. Surprised on D-Day (they were on leave in the south of France), the Abbeville Boys could do little to halt the invasion. As they abandoned their old base, once-friendly French civilians lurked in the background with increasing menace. Flying back home to Germany, he was nearly shot down by a flight of Mosquito night fighters. He underwent a horrifying Allied bombing raid. The Abbeville Boys undertook pitifully outnumbered attacks on well-escorted formations of B-17s and in the last



Luftwaffe offensive, Operation Bodenplatte, flown against Allied airfields in the low countries on New Year's Day 1945. These missions offered no relief from the Abbeville Boys' increasing disillusionment and fatalism. Eventually the last two survivors were shot down on a futile mission on the war's last day.

Bloemertz alone survived. His memoir, originally published in 1951 and translated into English in 1955, is now being published in the United States. Its evocation of "knights of the air" flying off in their formal uniforms and chivalrously treating downed "Tommies" to a meal at the mess seems badly outdated. But this was merely the convention prevailing when the book was written. The anachronisms do not obscure the author's descriptions of once-swaggering aerial warriors watching everything fall apart.

—Jack Breihan is a professor of history at Loyola College in Baltimore, Maryland.

Carrier Clash: The Invasion of Guadalcanal and the Battle of the Eastern Solomons, August 1942 by Eric Hammel. *Pacifica Press*, 1997. 358 pp., \$29.95 (hardcover).

In *Carrier Clash*, Eric Hammel has crafted a factual account of the U.S. invasion of Guadalcanal and subsequent sea battles that maintains the pace of a novel.

The author opens, logically enough, at the beginning of carrier-based aircraft warfare in 1918. Hammel briskly reviews the origins of U.S. naval air power—or lack thereof—before setting the scene for the dramatic invasion of Guadalcanal in August 1942.

That's when the action begins—the author brings his readers through a day-to-day account of the time leading up to the battle. By weaving anecdotes from the participants—the fliers and Marines who were on the scene—with the overall tactical and strategic plans, Hammel builds a picture with enough detail to hold the reader's interest but not so much that he overwhelms.

Hammel puts his readers into the cockpits of the scout planes, bombers, and fighters of the U.S. fleet. He introduces us to the men who flew Avengers, Wildcats, and Dauntless dive

AIR TRANSPORT

Airlines of Asia Since 1920 by R.E.G. Davies. *Paladwr Press*, 1997. 572 pp., b&w photos, \$65.00 (hardcover).

Trans Brasil: An Airline and Its Aircraft by R.E.G. Davies, illustrated by Mike Machat. *Paladwr Press*, 1997. 64 pp., color and b&w photos, color illustrations, \$30.00 (hardcover).



Ron Davies began to write *Airlines of Asia* a decade ago; the result is a meticulously detailed account of air service in Asia. Davies, the air transport curator of the National Air and Space Museum, is widely recognized as perhaps the premier authority on airlines, their aircraft, and their service. *Airlines of Asia* was first published in England by Putnam Aeronautical Books, recognized for publishing authoritative aviation reference works.

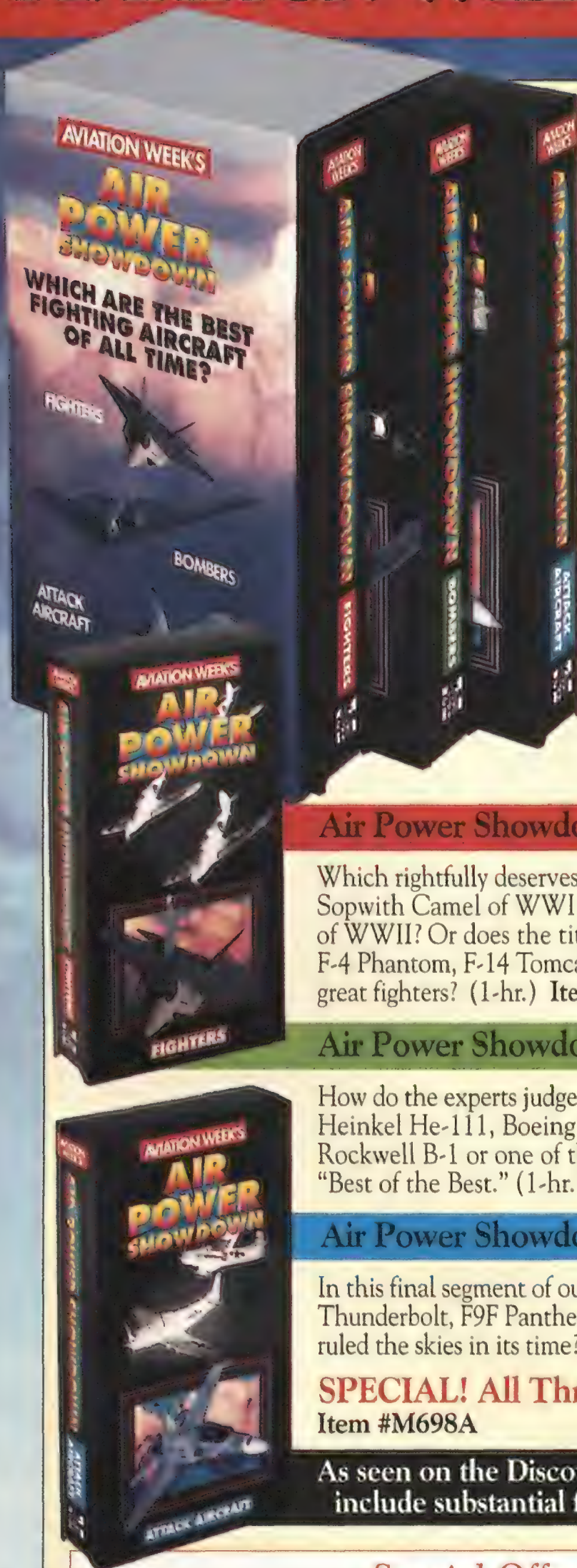
Trans Brasil is the sixth in a series of books by Davies that spotlight notable airlines. Included are



beautiful illustrations of colorful paint schemes. Other books in the series have featured

Pan American, Lufthansa, Delta, Aeroflot, and Saudia.

AVIATION WEEK's Preferred Gift



AIR POWER SHOWDOWN

Featuring the Best Fighters, Bombers and Attack Aircraft of All Time

In this exclusive video series, you'll take flight with 25 of military aviation's top pilots, commanders and historians to identify – once and for all – the very best fighting aircraft of all time. View stunning aerial photography of dogfights, night missions, bombing runs and more. Attend revealing interviews with Gunther Rall, Boots Blesse, Robin Olds, John Glenn and other aviation greats. What were, and are, the top fighters, bombers and attack aircraft? Which deserve to be called “the best?” You be the judge.

Air Power Showdown: The Best Fighters

Which rightfully deserves to be called the best? Was it the venerable Sopwith Camel of WWI? The Messerschmitt BF 109 or the P-51 of WWII? Or does the title rightfully belong to the F-86 Sabre, F-4 Phantom, F-14 Tomcat, F-16 Falcon or any one of a dozen other great fighters? (1-hr.) Item #M640A \$24.95 (plus s&h)

Air Power Showdown: The Best Bombers

How do the experts judge a bomber? Find out whether the Zeppelin, Heinkel He-111, Boeing B-29, Convair B-36, Boeing B-52, or Rockwell B-1 or one of the other great bombers will earn the title, “Best of the Best.” (1-hr.) Item #M665A \$24.95 (plus s&h)

Air Power Showdown: The Best Attack Aircraft

In this final segment of our series, cast your vote for the Sopwith Salamander, A-20 Havoc, P-47 Thunderbolt, F9F Panther, F-105 Thunderchief, or A-10 Thunderbolt II and more. Which one ruled the skies in its time? (1-hr.) Item #M688AX \$24.95 (plus s&h)

SPECIAL! All Three Just \$59.95 (plus s&h) Save 20%
Item #M698A

As seen on the Discovery Channel. Air Power Showdown Videos include substantial footage not shown in the broadcast version!

Special Offer – EARN A FREE GIFT!
FREE with your order of \$95 or more

Keith Ferris' “Force for Freedom” USAF 50th anniversary commemorative poster — a beautiful full-color poster edition, lithograph-printed on heavy stock. Measures 27” x 15”. A \$25 value!



Limited Time Savings Offer!



Help Young Minds Take Flight with Unique LIFTOFF! Kits

These learning kits bring the high-tech world of aviation and space flight down to earth. With exciting videos, stimulating posters, concrete explanations and hands-on activities, students can unravel the seeming mysteries of basic science and math concepts through the experience of the aerospace industry's top engineers, pilots and astronauts! Each kit features two 25-minute VHS videos, a stimulating poster, how-to activities, reproducible activity sheets and a teacher's guide loaded with ideas for hands-on exploration. Strap in and prepare for LIFTOFF! Grades 3-8.

Forces & Motion – Teaches basic principles of flight, including Newton's Laws of Motion and Universal Gravitation. Demonstrates lift, drag, thrust and gravity. Item #M980A \$59.95 (plus s&h)

Life in Flight – Explores human respiratory, circulatory and nervous systems and how they respond and adapt to air and space flight. Includes interviews with astronauts and pilots. **Item #M986A \$59.95 (plus s&h)**

Astronomy – Looks at how humans can live in and explore outer space. Examines space navigation, the effect of life without gravity and establishing a space colony.
Item #M965A \$59.95 (plus s&h)

Weather & Climate – Identifies the forces that produce weather and the aviation and space technologies that provide forecasts and track violent storms.

Item #M972A \$59.95 (plus s&h)

Produced by McGraw-Hill School Publishing and AVIATION WEEK
in cooperation with the Arts & Entertainment Network.

Save Now on These AVIATION WEEK Collectibles
Call 1-800-LIFTOFF to Order

Or 513-735-9000.

In Europe, call 49 (Germany) 611 22042.

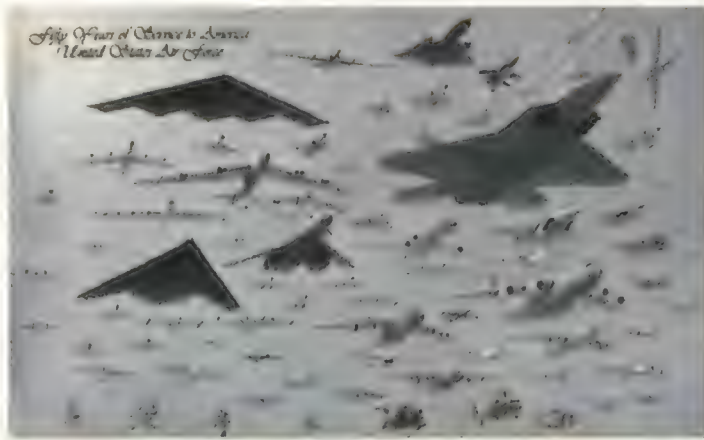
**For a complete list of AVIATION WEEK's Preferred Gifts,
fax your business card to 212-512-4225.**

Celebrate 50 Years of USAF Tradition with Keith Ferris' "Force for Freedom"

Only Keith Ferris could capture the detail and spirit of these 75 air and space vehicles, flown by the United States Air Force since 1947. The original appeared in our April 16th, 50th anniversary commemorative issue; now you can own a unique copy of this stunning artwork – sure to increase in value! You'll receive a signed and numbered 28" x 20" limited edition print, complete with a Certificate of Authenticity and an Aircraft ID Guide. Insured delivery available (Continental US).

"Force for Freedom" Limited Edition Print

Item #P3771W \$185 (plus s&h)



Force for Freedom
by Keith Ferns

Linux Edition Print © 1997 Addison-Wesley & Space Technology

AVIATION WEEK Preferred Gifts – Summer/Fall Savings Edition

Yes! Please send the gifts I've indicated. If I'm not happy, I can return them within 30 days for a prompt refund, less shipping. European customers specify PAL format here ► ☐

☐ Please fax me information on the complete line of AVIATION WEEK's Preferred Gifts

Qty.	Item #	Description	Price	S/H*	Total
*Shipping, Handling & Insurance			Subtotal		
<u>Merchandise Total</u>		<u>Add:</u>	Shipping & handling		
Up to \$30.00		\$ 5.75	NY residents add sales tax		
\$30.01 to \$60.00		\$ 6.75			
\$60.01 to 100.00		\$ 7.75			
\$100.01 to \$150.00		\$ 9.75			
Over \$150.00		\$ 13.75	TOTAL		

Name _____ Title _____

Company _____

Street _____

City _____ State _____ Zip _____

Payment Method: ☐ VISA ☐ MasterCard ☐ American Express ☐ Discover

Card # _____ Expiration Date _____

Signature _____

Daytime Phone (in case we have a question) (____) _____ Fax (____) _____

Fax or Mail to: Sporty's Pilot Shop, AIR POWER SHOWDOWN

Clermont County Airport, Batavia, OH 45103-9747

Call: Toll-Free 1-800-LIFTOFF or 513-735-9000 or Fax: 513-735-9200

PAL FORMAT: 49 611 22042 or Fax: 49 611 20898

AS

bombers—the stars of *Carrier Clash*. The pilots contend with boredom, terror, anger, and fear while hunting and fighting their Japanese counterparts in the skies over Guadalcanal.

These men are a brave lot, the author points out. They fling their airplanes off the wooden decks of the *Enterprise*, *Saratoga*, and *Wasp* never knowing if they will have a ship to land on when they return—if they return. Their courage is equalled by that of the Marines who occupy the island and endure waves of attacks from the sea, air, and land.

Hammel provides a seemingly unbiased assessment of the strategic and tactical situations from both sides as the U.S. and Japanese task forces maneuver to locate each other. In the end, Japanese carrier planes find and attack the *Enterprise* in a battle scene filled with flak and smoke.

Carrier Clash keeps you turning pages until the last flier is home. Could you ask for anything more?

—Mark McKellar is a freelance writer specializing in aviation.

The Mighty Eighth: The Air War in Europe as Told by the Men Who Fought It by Gerald Astor. Donald Fine, 1997. 464 pp., b&w photos, \$26.95 (hardcover).

Scarcely one month after the Japanese attack on Pearl Harbor, the U.S. Army activated its British-based Eighth Air Force, which would soon prove to be an aerial phalanx of unprecedented power. Such is the basic outline of the tale that has already been told by many a chronicler. But oral historian Astor presents the story of the air war over Europe at a most intimate level, through the words of the men who served in the Eighth. The author weaves recollections with a narrative that places individual stories within a retelling of the war's history.

The individual anecdotes are nearly impossible to resist, such as that of a young gunner hastily pulled from KP duty—where he has been relegated for some minor misdeed—and bundled into a dress uniform so that he can receive the Medal of Honor during a surprise visit from Secretary of War Henry L. Stimson.

Some of the most affecting stories are

of life behind enemy lines. In one episode, a courageous American colonel urges his fellow prisoners of war to resist the machinations of their German guards. Charged with inciting a riot, the colonel is placed for months on end in a tiny six-by-eight-foot cell. The ordeal is made bearable by the surreptitious support of his men.

The connecting narrative, too, is of great interest. Astor provides fascinating background on some of the greatest names in Army Air Force history. But sadly, Astor notes, "The generations born since can hardly appreciate what their fathers and grandfathers experienced...." We can only hope this book will help to change that.

—Susan Katz Keating wrote "Plausible Denial" for the Apr./May 1997 issue.

Fokker: A Transatlantic Biography by Marc Dierikx. Smithsonian Institution Press, 1997. 250 pp., b&w photos, \$35.00.

This is not a comprehensive history of the aircraft Tony Fokker and his companies built from 1910 until 1996. While his more important aircraft are certainly covered, Marc Dierikx does not attempt to catalog, describe, or illustrate every machine that carried Fokker's name. As noted in the preface, other authors have done ample justice to Fokker's airplanes.

Instead, Dierikx aims to tell us about Fokker himself, a story he believes others have missed. I believe Dierikx has met his goal, in part because as a fellow Dutchman he was better able to mine the many Dutch archives he cites in his comprehensive and meticulous end notes. Read this book to find out who Tony

BOOK BRIEFS

American Eagles: A History of the United States Air Force by Ron Dick, photographs by Dan Patterson. Howell Press, 1997. 464 pp., color and b&w photos, \$65.00 (hardcover).



American Eagles reviews the last 50 years of the U.S. Air Force and includes aviation art, 275 historical photographs, and more than 300 new photographs of aircraft in the Air Force Museum collection. A limited, leather-bound edition that includes 40 original signatures of such aviation legends as Chuck Yeager, Robin Olds, and Ben Davis is available for \$500.

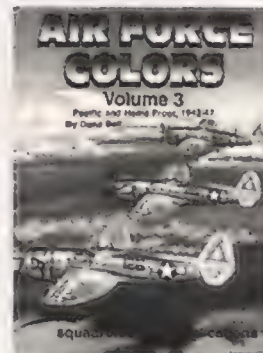
The Naval Institute Guide to World Military Aviation, 1997-1998 by René J. Francillon. Naval Institute Press, 1997. 884 pp., b&w photos, \$150.00 (hardcover).



Need to know how many Mi-17 helicopters the Number 1 squadron of the Bangladesh air force flies? If someone comes up with a Trivial Pursuit game for aviation, this book will be invaluable. *The Guide to World Military Aviation* is good for more mainstream information too, like how many aircraft, by type, are flown by each branch of the

United States military. The first half of the book lists countries and their air arms, while the second half lists aircraft and the countries that operate them.

Air Force Colors Volume 3: Pacific and Home Front, 1942-1947 by Dana Bell. Squadron/Signal Publications, 1997. 95 pp., color and b&w photos, \$14.95 (paperback).



The third volume of a trilogy on unit markings by Dana Bell, a National Air and Space Museum archivist, Volume 3 includes rare photos of little-known markings. Volumes 1 and 2 are also available, and cover 1926-1942 and 1942-1945, respectively.

United States Naval Aviation: 1910-1995 by Roy A. Grossnick. Naval Historical Center, Department of the Navy, 1997. 811 pp., b&w photos, \$73.00 (hardcover).



A chronology that starts as early as 1898, before the official 1910 birth of naval aviation. Available through the Government Printing Office. Can also be ordered on CD ROM.

Fokker really was and how he operated.

Fokker's achievements are legendary. In 1910, he flew an airplane he had helped design and build, and the following year he flew an aircraft exclusively of his own design to public acclaim in Haarlem on the Queen's birthday. Fokker built the Fokker D.VII, a fighter so respected by the Allies that the 1918 Armistice agreement specified that all D.VIIIs be seized. His F.VII series of tri-motor airliners operated throughout the world and across the oceans in the 1920s.

While describing Fokker's triumphs, Dierikx also delves into the less attractive aspects of his life. He shows the energetic and ambitious high school dropout, inventive as a young man, later prospering mainly on the ideas of others (not always with their permission) and never progressing much beyond the technologies of the late 1920s.

Fokker also changed his citizenship to suit the circumstance. He became German to please his main customer in World War I, and when that war was lost, he returned to neutral Holland (with 350 rail cars of airplanes, engines, and equipment snatched from Allied seizure) and regained his Dutch citizenship. In 1925 he emigrated to the United States, where business opportunities were better.

Fokker's personal life was often tragic.



His considerable wealth couldn't prevent his first marriage from ending in divorce, and his second marriage ended when his young wife plunged out of their 15th floor apartment window in New York, a suspected suicide. His own death at age 49 in 1939, from complications following minor surgery, probably would have been prevented a few years later when antibiotics became available.

The relationship between the Dutch government, Fokker, and KLM was important to Fokker's success. The government wanted a viable aircraft industry in order to provide warplanes with which to defend the nation's neutrality. It pressured KLM to buy Fokker airliners, even though they were inferior and overpriced. This resulted in longstanding animosity between Fokker and KLM's legendary head, Albert Plesman. But it also led to Fokker's becoming the European agent for Douglas when KLM needed the DC-2, far superior to any other airliner in the world. Fokker made good money on this deal, which Dierikx describes as originally Plesman's idea.

Although Dierikx had no intention of producing a technical or photo history, there are places where one or two pictures or explanations would have been helpful. Dierikx states that last-minute changes were made to Fokker's entry in the February 1918 German fighter competition, but he doesn't tell us that the main change was lengthening the D.VII's fuselage by two feet. In the late 1930s, Fokker's Dutch factories began to expand production with pre-World War II rearmament. Two of Fokker's best new warplanes were the D.XXI and G.I fighters, the latter revolutionary for its time. A photo of each would have been useful.

Dierikx repeatedly criticizes Fokker for not investing in modern plants and equipment, and he blames insufficient investment for the inability of Fokker's airplanes to compete with Douglas and Lockheed products in the 1930s. This is no doubt true, but no other airliners were competitive with the American machines either. The Fokker company enjoyed a steady resurgence in World War II, but succumbed to stiff international competition in 1996, 57 years after its namesake's death.

—Sam Smith is a commercially licensed pilot and amateur aviation historian.

TAKE TO THE SKIES

SPACE AND THE AMERICAN IMAGINATION

HOWARD E. McCURDY

Examining the popular images that have helped motivate the most ambitious space program in the world, Howard E. McCurdy argues that the spacefaring dream as portrayed in movies, magazine articles, and television shows such as *Star Trek* has tapped into several of America's most deeply rooted ideals: the limitless frontier, the romance of aviation, and economic progress through technology.

43 b&w photographs 416 pp. • Hardcover \$29.95
Smithsonian History of Aviation Series

VISIONS OF A FLYING MACHINE

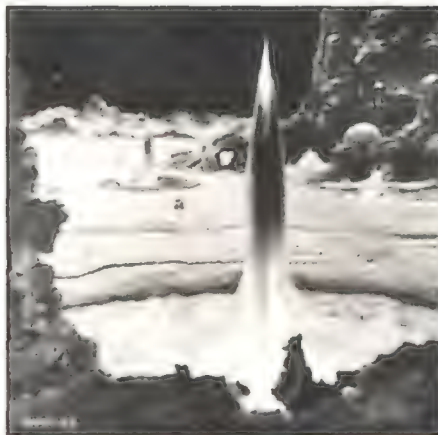
The Wright Brothers and the Process of Invention

PETER L. JAKAB

FOREWORD BY TOM D. CROUCH

Exploring the experiments that led to Wilber and Orville Wright's momentous flight at Kitty Hawk in 1903, Peter L. Jakab draws on letters, diaries, notebooks, sketches, photographs, and reconstructions of their aerodynamic tests to show how the Wright Brothers visualized solutions to technical problems that had baffled scientists for more than a century.

62 b&w illustrations 272 pp. • Paperback \$15.95
Smithsonian History of Aviation Series



Courtesy Bonestell Space Art.



Courtesy Donald S. Lopez.

WINGS AND WARRIORS

My Life as a Naval Aviator

DONALD D. ENGEN

Recalling a career that encompassed dive bombing in the Pacific during World War II, flying the first jets of the Navy, breaking altitude records as a test pilot, and commanding the *USS America* during the 1960s, Donald D. Engen conveys the excitement of flight and documents the remarkable progress of naval aviation during the golden age of jet airplane development.

44 b&w photographs 424 pp. • Hardcover \$29.95
Smithsonian History of Aviation Series

INTO THE TEETH OF THE TIGER

DONALD S. LOPEZ

This book provides a vivid, pilot's-eye view of one of the most extended projections of American air power in World War II Asia. Chronicling every aspect of fighter combat in the China campaign, the author describes harrowing aerial battles, interludes of boredom, and instances of courage and cowardice.

24 b&w photographs 272 pp. • Paperback \$17.95
Smithsonian History of Aviation Series

WITH **SMITHSONIAN INSTITUTION PRESS**

PO BOX 960 • HERNDON, VA 20172 • 800/782-4612

PACIFIC AIRCRAFT THE COLLECTOR'S CHOICE

Makers of Fine Aerosculptures

**Hand Carved
From Solid
Mahogany**

Exquisitely hand
painted markings
and details.

- Museum quality
- Sizes 16" to 22"
- Stand included
- From \$99.50

Satisfaction
Guaranteed

**OVER 250
MODELS
IN STOCK**

**CALL (800) 950-9944
FOR CATALOG AND ORDERS**



14255 N 79th Street, Scottsdale, AZ 85260. Phone (602) 991-1841, <http://www.warplanes.com>

HANDCRAFTED AVIATION DISPLAY MODELS

Over 500 Aviation Display Models Available

LOCKHEED/USAF T-33A SHOOTING STAR
(1/48th = W/S: 10.25")
@ \$99.95 + \$9.00 S/H

SHOWCASE MODEL CO.

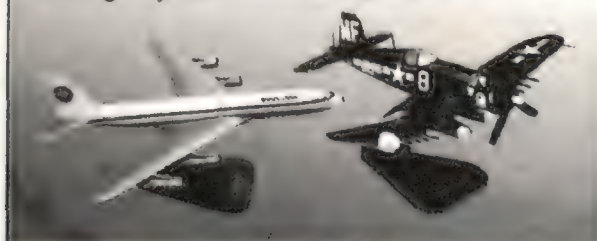
P.O. Box 129, Dept. A/S-97-12
Covington, OH 45318-0129 U.S.A.
(800) 441-9524 - Orders ONLY
(937) 473-5725 - Catalogs/Questions
(937) 473-5727 - FAXES



WORLD'S LARGEST MAKER OF AEROSPACE REPLICAS



AVIATION MODELS The Airplane Shop
has the largest selection of commercial & military
aviation models & collectibles! Fully assembled,
meticulously detailed, complete with stand. Color
catalog only \$2. refundable with order.



THE AIRPLANE SHOP

18 PASSAIC AVENUE, UNIT 6, FAIRFIELD, NJ 07004
TEL: 1-800-PLANE-GO • FAX: 973-244-1227

Visit our website
at
www.airspacemag.com

AIRLINER NUT? World's Largest

selection of airline and airliner related items: books, videos,
models, calendars, shirts, posters, pins, magazines, etc.,
including our own **AIRLINERS**, The World's Airline
Magazine. Call (800) 875-6711 or (305) 477-7163, fax (305)
599-1995 or write: AIRLINERS Catalog, PO Box 521238/AS,
Miami, FL 33152-1238 USA for a free fully-illustrated catalog.

**Korolev: How One Man
Masterminded the Soviet Drive to
Beat America to the Moon** by James
Harford. John Wiley & Sons, 1997. 392
pp., b&w photos, \$30.00 (hardcover).

Piecing together the real story behind the Soviet space program has always been a frustrating business. During the cold war, state archives were off limits to Western researchers and serious interviews with the principals were virtually forbidden. Now the archives are mostly open (some material is even on the Internet), and the participants can speak freely. But there is a new problem: official records have often been grossly distorted for political reasons, and the memories of the surviving space pioneers and their close relatives can be highly selective.

James Harford, a veteran of the U.S. space program and a former fellow of the National Air and Space Museum, has waded into the quagmire and come out with as good a look as we are likely to get at the Soviet space program's enigmatic



"chief designer," Sergei Pavlovich Korolev. A mound of reading and interviews with 63 Russians (including Korolev's surgeon daughter, close friend and colleague Boris Chertok, successor Vassily Mishin, and

cosmonauts Alexei Leonov and Gherman Titov) have produced a balanced and richly detailed picture of the talented designer. Korolev masterminded Sputnik, Yuri Gagarin's epic flight, and the frustrating and ill-fated race to the moon against the United States, and even produced ballistic missiles and reconnaissance satellites. And this from a man whose health was severely damaged in one of Stalin's gulags, who labored in an always uncertain industrial environment, and who worked with rivals who constantly tried to undermine him for the good of their own design bureaus (Winston Churchill likened such Soviet infighting to "dogs fighting under a carpet"). Engine designer Valentin Glushko, Korolev's relentless rival, was one of three rocketeers whose testimony sent Korolev to the gulag in the first place.

The portrait that emerges is that of a driven and volatile individual, given to pampering and protecting his beloved cosmonauts and verbally flagellating engineers and technocrats who made serious mistakes. And for all his contributions, he had to endure an anonymity that must have been galling—

Nikita Khrushchev was afraid the CIA would assassinate Korolev—while the cosmonauts, his beloved “falcons” or “little eagles,” were treated like Western film stars. To his credit, the author carefully lays out Korolev’s singular achievements without either sentimentalizing or overblowing them. He repeatedly, and quite correctly, gives the “space visionary” Mikhail Tikhonravov much of the credit for Korolev’s successes, for example.

More than anything else, Korolev’s genius lay not in cutting-edge missile and spacecraft designs but in a clear vision, a grasp of several technologies and the ways they could be integrated, an ability to work with Khrushchev, and a degree of charisma that made those he favored work like dogs for him.

The ultimate tragedy is that the succession of triumphs, all of them crowded by Khrushchev in what today would be called in-your-face politics, started a relentless journey in the United States that ended on the moon. At least Korolev, who died undergoing surgery for intestinal cancer in 1966, did not live to see that ignominious defeat.

—Aerospace historian William E. Burrows is a contributing editor of *Air & Space*/Smithsonian, the director of the *Science and Environmental Reporting Program* at New York University, and the author of several books. His latest, *This New Ocean, a history of the first space age, will be published next year.*

Statement of ownership, management, and circulation (required by 39 U.S.C. 3685) of AIR & SPACE/ Smithsonian, published bimonthly at the Smithsonian Institution, 900 Jefferson Drive, Washington, DC 20560 for September 26, 1997. General business offices of the publisher are located at 900 Jefferson Drive, Washington, DC 20560. Name and address of publisher: Ronald C. Walker, 900 Jefferson Drive, Washington, DC 20560. Name and address of editor: George C. Larson, 370 L'Enfant Promenade, SW, 10th Floor, Washington, DC 20024. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities: None. The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes have not changed during preceding 12 months (Section 411.3 DMM). The average number of copies of each issue during the preceding 12 months are: (A) Total number of copies printed: 326,638; (B) Paid circulation: (1) Sales through dealers and carriers, street vendors, and counter sales: 27,901; (2) Mail subscriptions: 248,599; (C) Total paid circulation: 276,500; (D) Free distribution by mail: 2,118; (E) Free distribution outside the mail (carriers or other means): 3,572; (F) Total free distribution: 5,690; (G) Total distribution: 282,189; (H) Copies not distributed: (1) Office use, left-over, unaccounted for, spoiled after printing: 2,916; (2) Return from news agents: 41,533; (1) Total: 326,638. Percent paid and/or requested circulation: 97.9%. The actual number of copies of single issue published nearest to filing date are: (A) Total number of copies printed: 324,130; (B) Paid circulation: (1) Sales through dealers and carriers, street vendors, and counter sales: 30,722; (2) Mail subscriptions: 244,791; (C) Total paid circulation: 275,513; (D) Free distribution by mail: 2,444; (E) Free distribution outside the mail (carriers or other means): 2,719; (F) Total free distribution: 5,163; (G) Total distribution: 280,676; (H) Copies not distributed: (1) Office use, left-over, unaccounted for, spoiled: 2,321; (2) Return from news agents: 41,133; (1) Total: 324,130. Percent paid and/or requested circulation: 98.1%. I certify that the statements made by me are correct and complete.
Shelia Brannum
Business Manager

"We Came in Peace for All Mankind"

On July 20, 1969, Buzz Aldrin became one of the first two human beings to walk on the moon. On March 3, 1997, he made history again by crafting the finest limited-edition Apollo 11 autographed print ever created. On only 75 hand-printed & numbered sheets of color 16 by 20 inch photographic paper, he inscribed the following, using archival ink:

July 20, 1969

"We came in Peace for all Mankind"

Buzz Aldrin
Lunar Module Pilot
Apollo 11



Within this hand-written statement is the date the photo was taken, a quote of the last line from the historic plaque left on the moon, and a description of his mission role as Lunar Module Pilot.

Each print comes shrink-wrapped with matching numbered **Certificate of Authenticity**

\$495⁰⁰ per print, which includes 2 Day Fed Ex delivery

DAVID FROHMAN'S
PEACHSTATE HISTORICAL CONSULTING, INC.

2625 Piedmont Road • Suite 56-106 • Atlanta, Georgia 30324

Toll Free (888) 644-7322

Take Care of Your Holiday Shopping the Easy Way

Are you looking for something different to give as a holiday gift this year? Do you know someone fascinated by weather? Give a subscription to **Weatherwise** magazine to solve all your problems.

Weatherwise, celebrating its 50th anniversary, explores weather phenomena through intriguing articles, amazing first-person accounts, and breathtaking color photos. Annual features in this award-winning magazine include the Photo Contest and almanac issues.

For just \$29* you or a friend can receive a year of **Weatherwise**. Send or fax in the coupon to start your subscription today!



Weatherwise
Heldref Publications
1319 Eighteenth St., NW
Washington, DC 20036

202-296-6267
Fax 202-296-5149
1-800-365-9753

www.heldref.org/
ww/www.html

*(58 for institutions)

Please send a subscription to:

Name _____

Address _____

City/State/Zip _____

Charge the subscription to:

Name _____

Address _____

City/State/Zip _____

Visa/MasterCard # _____

Exp. date _____

MISS AMERICA AIR RACING TEAM PRESENTS ARTIFACTS OF THE WILD BLUE YONDER



- Posters & limited edition prints by John Batchelor
- Willis & Geiger leather flight jacket hand painted by Ron Kaplan
- Highly detailed 1:48 scale die cast metal model by Marushin
- Sportswear, wearable art & other artifacts of the Wild Blue Yonder

Free catalog **888-410-0206** toll-free call

MISS AMERICA
SPONSORS &
PARTNERS

idwell
PRINTING

AVIATION

WILLIS & GEIGER

Visit us on the web at: www.MissA.com

Custom Aircraft Replicas

*Models so realistic, you expect
them to take flight...*



We specialize in custom mahogany replicas. Virtually any aircraft from World War I through present day. Squadron Group orders welcome!

Call today for your free color brochure and see the quality our customers have come to expect.

(800) 732-6875 or (316) 788-0128

Anderson

Fine Scale Replicas

405 Osage * Derby, Kansas * 67037

CREDITS

Nap of the Earth. Alan Duaine, an old cold warrior and ex-airline pilot, still flies. Now he lands Boeing 727s on his former nuclear targets: fighter base runways from East Germany to Russia.

You Heard It Through the Grapevine. Next to his commercial pilot's license, frequent contributor Stephan Wilkinson carries in his wallet the certificate of a full-time skeptic.

Catch a Falling Missile. Tony Reichhardt is a contributing editor to *Air & Space/Smithsonian*. Now that he's seen the view from Ground Zero, he hopes never to see it again.

Sky Raves. Frank Kuznik is an *Air & Space* contributing editor.

Letters From the Front. Gary Lee, the grandson of Lewis Clifford Plush, served in the U.S. Coast Guard Reserve for six years. He lives on the family ranch, where they still name dogs Spad.

Further reading: *War Birds: Diary of an Unknown Aviator*, John M. Grider, Texas A&M University Press, 1988.

Surfing the Solar System. Freelance writer Michael Milstein was reporting on hot springs in Yellowstone National Park when he first met scientists looking for similar liquid environments on other

worlds. He currently has a fellowship in environmental and science journalism at the University of Colorado.

Secret Mission to Tibet. William M. Leary is the E. Merton Coulter professor of history at the University of Georgia. During 1996-97, he served as the Charles A. Lindbergh professor of aerospace history at the National Air and Space Museum.

Further reading: *Perilous Missions: Civil Air Transport and CIA Covert Operations in Asia*, William M. Leary, University of Alabama Press, 1984.

The North American Fish Spotter. Joseph Bourque is a pilot and writer living in Bozeman, Montana.

Monster Engines. Bruce D. Berkowitz lives and writes in Virginia, and although he tinkers with space systems, his heart belongs to vehicles with wings.

Further reading: *Allied Aircraft Piston Engines of World War II*, Graham White, Society of Automotive Engineers, 1995.

High Society. Phil Scott hopes his next addition to the Royal Aeronautical Society's library will be *Canvas, Steel, and Wire: A Documentary History of Early Flight*, to be published by Princeton University Press (whenever he actually completes it).

CALENDAR

January 1

Sno'Fly: The First Kite Fly of the Year. Kite-making workshops for participants of all ages, sledding, ice fishing, and ice skating. Prizes will be awarded for Most Excellent Hat, Awesomest Earmuffs, and Best Decorated Sled. Prairie View County Park, Kalamazoo County, MI, (616) 383-8778.

January 3 & 17

USAF Heritage Tour: An Overview of Air Force History from 1907 to the Present. U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704.

January 4-9

"Who's Going to Pay for the FAA?" a seminar on establishing aviation policy. Sponsored by the University Aviation Association. Holiday Inn-Capitol, Washington, DC, (334) 844-2434.

January 14

Aviation Film Classic: *Von Richthofen and Brown*, a story about the legendary World War I German ace and the young Canadian pilot who reportedly shot him down. Carney Auditorium, U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704.

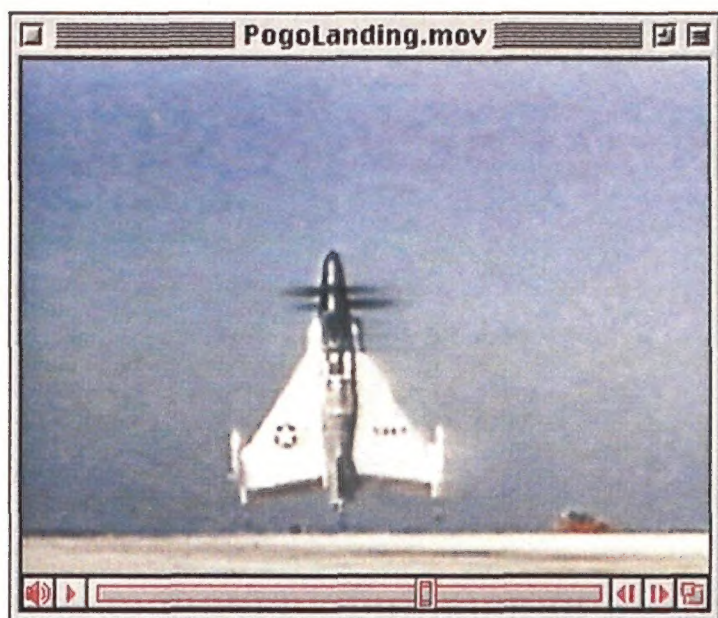
January 14 & 15

"Warfare in the Information Age," a conference sponsored by the U.S. Naval Institute. San Diego Convention Center, San Diego, CA, (703) 631-6200.

January 22

"Cold War Reconnaissance" and "Project Heart Throb: 1954-59," lectures by Donald Hillman and Major General Gerry Cooke, USAF (ret.). Carney Auditorium, U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704.

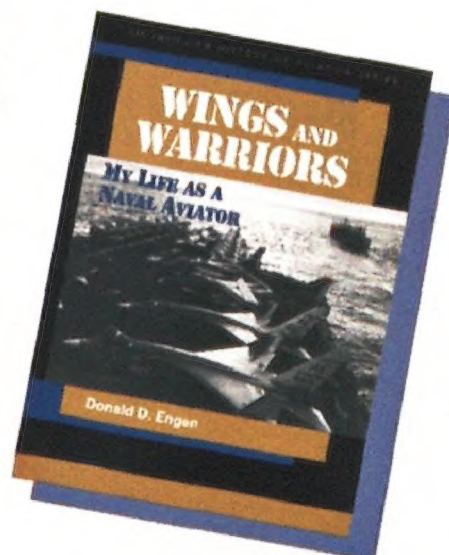
MORE MOVIES



Some things you must see to believe: a Beech Bonanza skimming under the legs of the Eiffel Tower, the Convair XFY-1 Pogo interceptor taking off and landing at attention. You can view QuickTime videos of these and other novelties-in-motion on Air & Space/Smithsonian's Web site.
(www.airspacemag.com/ASM/Web/Site/sightings.html)

Wings and Warriors

In a new memoir National Air and Space Museum director Donald Engen recalls 25 years of flying adventures in the Navy. *Wings and Warriors: My Life as a Naval Aviator* is now available through Air & Space magazine's Web Market.
(www.airspacemag.com/ASM/Mkt/Engen.html) or by telephoning 1-800-824-5974. (\$29.95 plus \$5 shipping and handling.)



FORECAST

In the Wings...



CAROLINE SHEEN

The Magic of Midway.

Retired from its historic Navy career, this tiny island air base still has a few battles left to fight and a fine welcoming committee on hand to greet its visitors.

The Outer Limits.

We're not just nine rocks circling the sun anymore; suddenly we're sharing the solar system with 28,000 planetesimals out beyond Pluto. There goes the neighborhood.

Igor Sikorsky's Little Bird.

Inspired by one of the world's great aircraft designers, two teams have re-created one of his earliest airplanes.

Norm Thagard's Wild Ride.

The only American astronaut to travel to orbit in a Russian rocket compares the experience with his space shuttle travels.

WE WANT YOU to be a Fighter Pilot!



Fly authentic WW II Warbirds in Air-to-Air Combat!

• Ground School • 2 Combat Flights • 4 Camera Video of Your Flights •
(No previous flying experience necessary)

Also:
Introductory Flights
Aircraft Checkouts & BFRs
Formation & Aerobatic Dual

Flying at locations throughout the USA



North American Top-Gun, Inc.

(904) 823-3505

(800) 257-1636

<http://www.natg.com>

Gift Certificates Available

• The World's Greatest Christmas Gift !! •

AVIATION ART

475th Ft. Gp.



Limited Edition Collector prints, signed / numbered
Art Center Studio, 23 Jones St., Providence, RI 02903

Navy Sq. VF-17

Free brochure: Phone (401) 421-2651, FAX (401) 421-2691

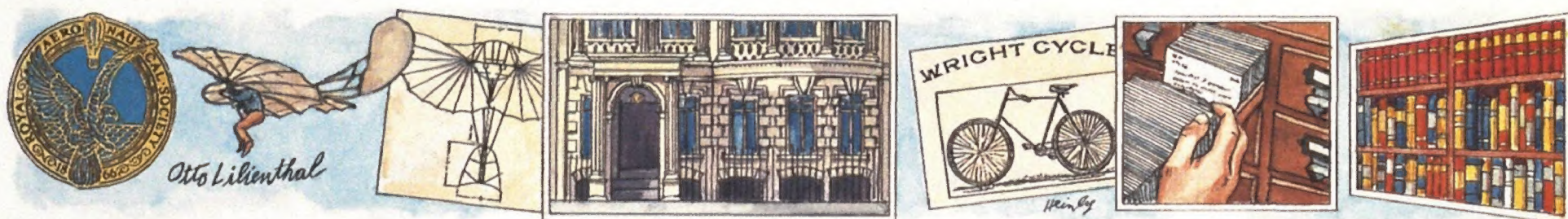
Celebrate July 4th & All Events CARBIDE CANNON BIG BANG! \$119.95

Mammoth Cannons shoot with terrific BANG! Have a bang-up time at special events. Uses powdered carbide ammo. Hundreds of shots for few cents. All metal construction with large, rugged cast iron wheels. Machined brass mechanism for easy loading and firing. Authentic turn-of-century design. Handsome decor when not in use. Made in USA to last a lifetime. Available in 3 sizes: 9" cannon, \$49.95 postpaid; 17" cannon, \$89.95 postpaid; 25" cannon (shown here) with rapid firing and automatic loading, \$119.95 postpaid. The larger the cannon the louder the bang! Carbide ammo, about 100 shots, \$6.00; 3-pack \$15.00. Spark plugs, 3-pack \$2.00. Send check, money order or call. Visa, MasterCard accepted by mail or phone. Give card number & expiration. Money-back guarantee. Send for FREE CATALOG!

The Conestoga Co., Inc., Dept A, PO Box 405, Bethlehem, PA 18016

★★ Call 1-800-987-BANG ★★

www.bigbangcannons.com



JOHN HEINLY

High Society

Around the corner from London's Hard Rock Cafe—and a couple of centuries away culturally—you'll find the headquarters of the Royal Aeronautical Society of Great Britain. With a name like that you would expect a terribly grand, terribly staid facade—and you wouldn't be disappointed.

The pristine Georgian townhouse is located just off Hyde Park and up the road a ways from Buckingham Palace. Acquired from the Crown in 1938, the house dates back to 1805; its last private owner was the chairman of Phoenix Oil, "who spared no expense to make the home one of the most dignified and gracious in London," according to the society's official history. And indeed, the house is resplendent, from its grand marble staircase to its clubby mahogany and walnut furniture to its portraits and busts of famous past society presidents and members.

Scattered throughout the house are minor treasures of aeronautical history: an original Blériot propeller, a silver trophy given to Adolphe Pégoud in 1913 to commemorate the first loop flown in Great Britain, a piece of fabric from the first human-occupied hot-air balloon, which ascended from Paris in 1783.

The society is well positioned to collect such artifacts: It is the oldest aviation organization in continuous existence. It was born in 1866, when six gentlemen came together in the home of the Eighth Duke of Argyll and proposed "to form a Society for the purpose of increasing by experiments our knowledge of Aeronautics." The duke became the society's first president, and at the group's first meeting, he contributed a bit to the body of aeronautics by taking issue with the popular notion that birds became airborne by filling themselves with hot air, like balloons. Also at that first meeting was Francis Wenham, who presented a now-classic paper, "On Aerial Locomotion," recounting his experiments with various airfoils. Wenham explained to his small audience that when it comes to producing lift, a curved, or cambered, wing works

better than a flat wing, and a long, narrow wing outperforms a stubby, square one.

In 1868 the society sponsored the world's first aeronautical exhibition, a competition held in London's immense Crystal Palace. Vying for prizes, inventors entered 77 designs, from various types of flapping wings to a steam-powered triplane. But despite all the imaginative energy devoted to the field, over the next three decades progress in aeronautics dropped off, and so did the society's membership; it fell from a peak of 100 in 1876 to just 40 by 1897.

The Royal Aeronautical Society of Great Britain, 4 Hamilton Place, London, England, W1V 0BQ. Phone 0171-499-3515; e-mail: library@raes.org.uk. Open by appointment Mon.-Fri., 10 a.m.-5 p.m. Admission: £10; members free.

Of course, the success of the Wright brothers six years later set off a renaissance in the field. The society's members grew in number and evolved from starry-eyed experimenters to professionals and captains of industry. And during those years of growth, the society moved into a series of ever-more-spacious digs. The current headquarters has meeting rooms, a lecture theater, and a bar and lounge.

The heart of the home, however, is the society's vast library, a collection of books (25,000), prints and lithographs (650), photographs (100,000), and journals (long runs of over 750 titles, current and past). The collection is extensive enough to make any bookish aviation aficionado positively lightheaded. "The library is unusual in the sense that it has been going so long that we have a tremendous historical aviation archive," says Brian Riddle, the society's low-key, rumpled, erudite deputy librarian. At any one time, about 20 percent of the collection is on display in the reading room; the rest is stored in the basement or tucked away in nooks and crannies.

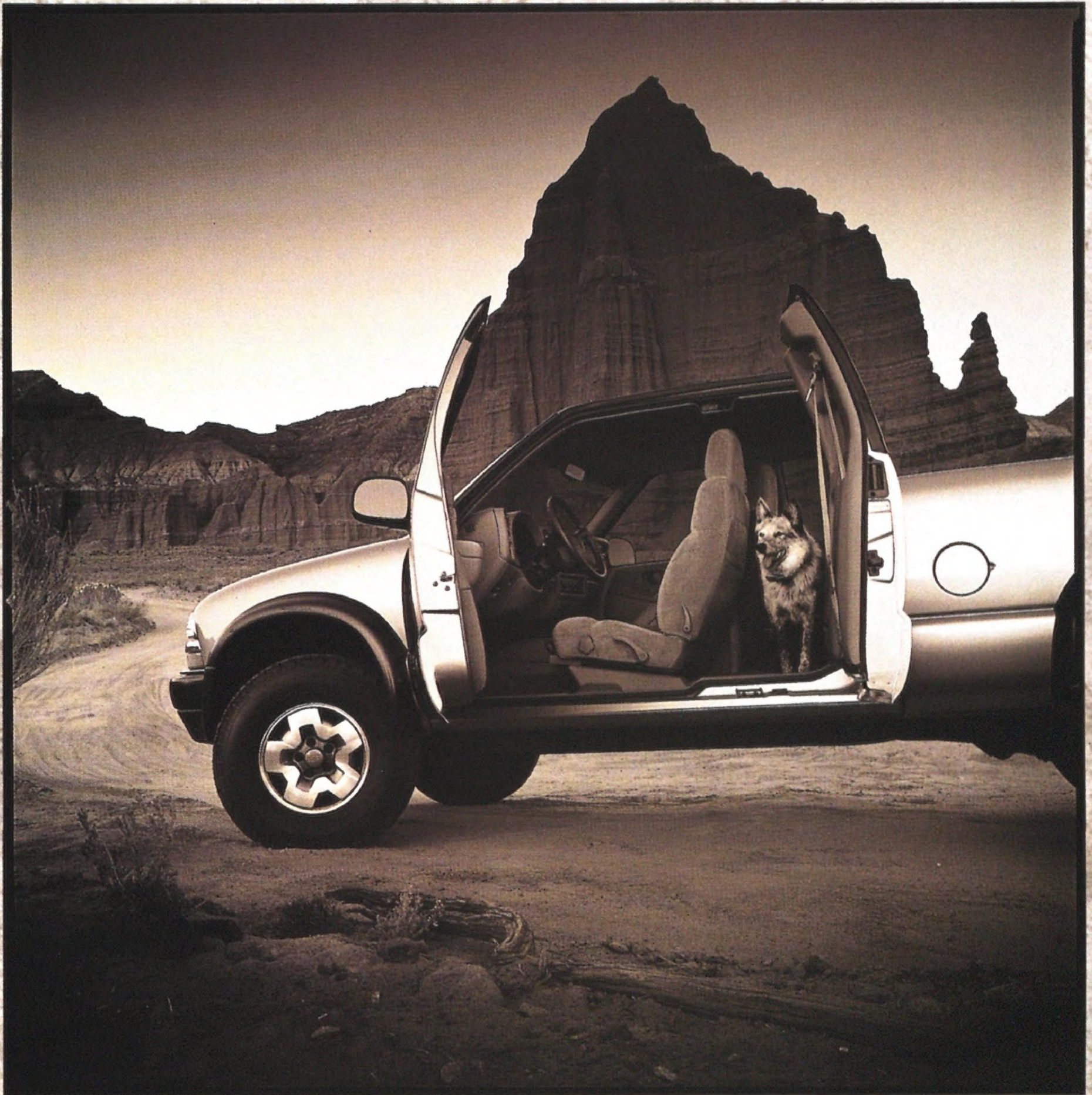
The library began life during that first meeting, when the charter members initiated a tradition that continues today: They contributed six volumes of aeronautica (four were in French, indicating, perhaps, how much more seriously France took the subject). Riddle tells me that over the years, "a lot of the pioneers gave their papers, books, and things to the society." From a bookcase he pulls a few notes written in the hand of Sir George Cayley, an early theorist who coined the term "aerial navigation" as a more respectable alternative to "flying." The society also has one of only two known copies of William Henson's 1843 patent drawings for the Aerial Steam Carriage—the first design for a powered monoplane—and it even has a mint condition catalog published in 1900 by the Wright Cycle Company. There are no flying machines advertised in it, only bicycles.

At the card catalog Riddle asks me if there is any title, any work, I care to peruse, and he does so with great confidence that it will be in the society's library. I start thinking of all the famous titles I've always wanted to hold in my hands: an original of Giovanni Alphonso Borelli's 1685 work, *De Motu Animalium*, on the possibility of a human-powered ornithopter; an 1889 printing of *Der Vogelflug als Grundlage der Fliegekunst* by glider pioneer Otto Lilienthal... But I want to make it hard for Riddle, so I give him the title of an obscure book on early attempts at manned flight—one that had a print run smaller than the Luddites' telephone directory and a shelf life shorter than a daily newspaper.

Riddle flips through one drawer, and there it is: *The Shoulders of Giants*. My first book.

Then he takes me around to another set of drawers, this one ordered by publication date. The first volume is *Noctes Atticae*, by Aulus Gellius, published in 1515. The last acquired book: mine. It is a moment humbling and exalting, all at the same time.

—Phil Scott



THE ONLY COMPACT TRUCK TO OFFER A THIRD DOOR.*

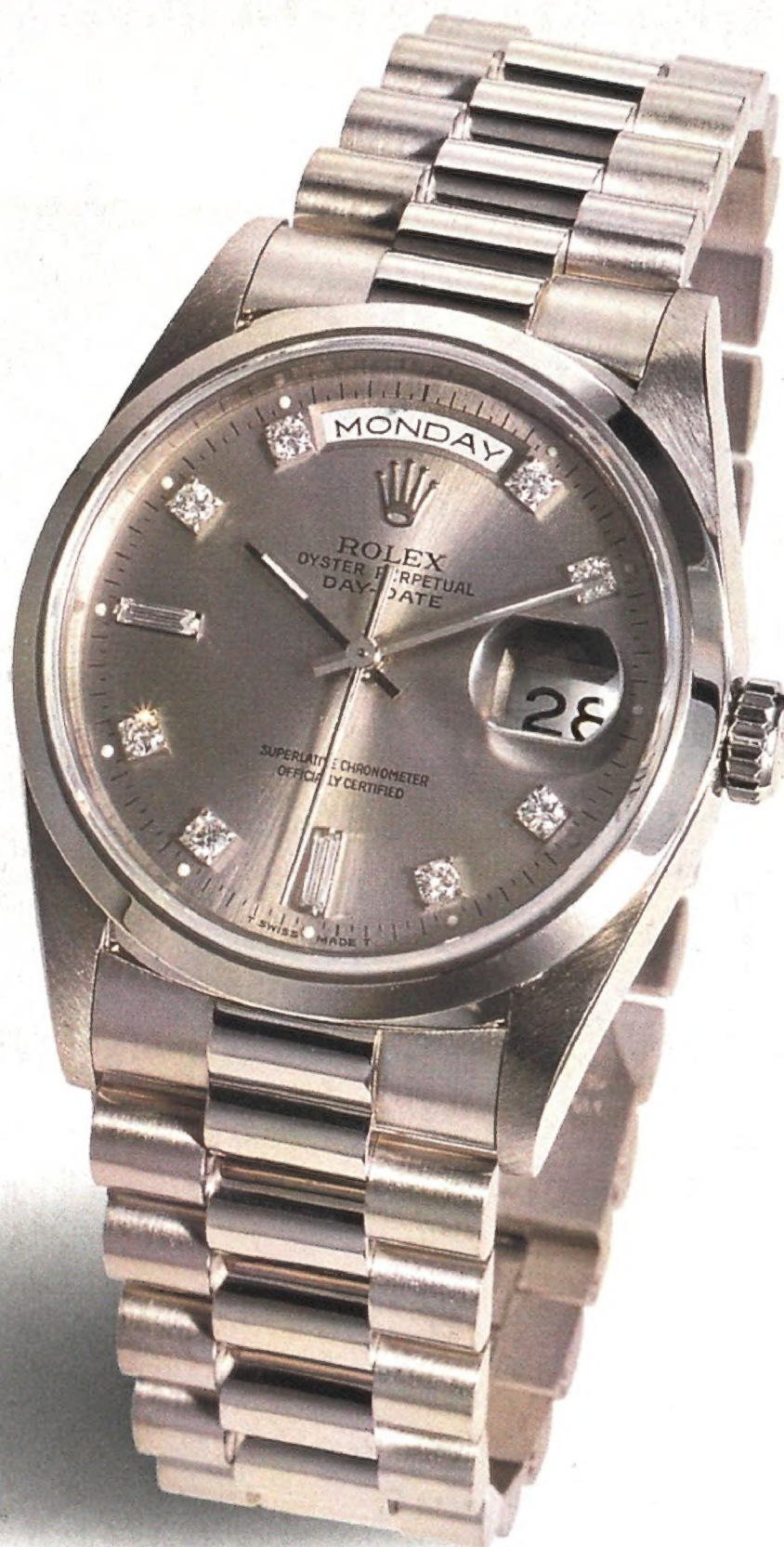
~ OR ~

A CLOSER LOOK INTO THE SOUL OF A REBEL.

www.chevrolet.com 1-800-955-2848

Chevy™ S-10® Like A Rock






The quality of platinum.

The modesty of steel.

One key to the legendary performance of a Rolex timepiece is its Oyster case which combines with the winding crown and synthetic sapphire crystal to protect the Perpetual movement. For the Rolex Day-Date pictured here, the case is sculpted from solid platinum.



Despite its remarkable tensile strength, the luster of platinum is so subtle it doesn't draw unwanted attention to itself. For the discriminating people who choose to invest in this special timepiece, this understated quality is just one more of its distinctive attributes.

Rolex Oyster Perpetual Day-Date in platinum with matching President bracelet and diamond dial. For the name and location of an Official Rolex Jeweler near you, please call 1-800-36ROLEX. Rolex, , Oyster Perpetual, Day-Date, Oyster and President are trademarks.


ROLEX